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OF THE

NATIONAL FIRE PROTECTION ASSOCIATION

"To Promote the Science and Improve the Methods of Fire Protection and Prevention."

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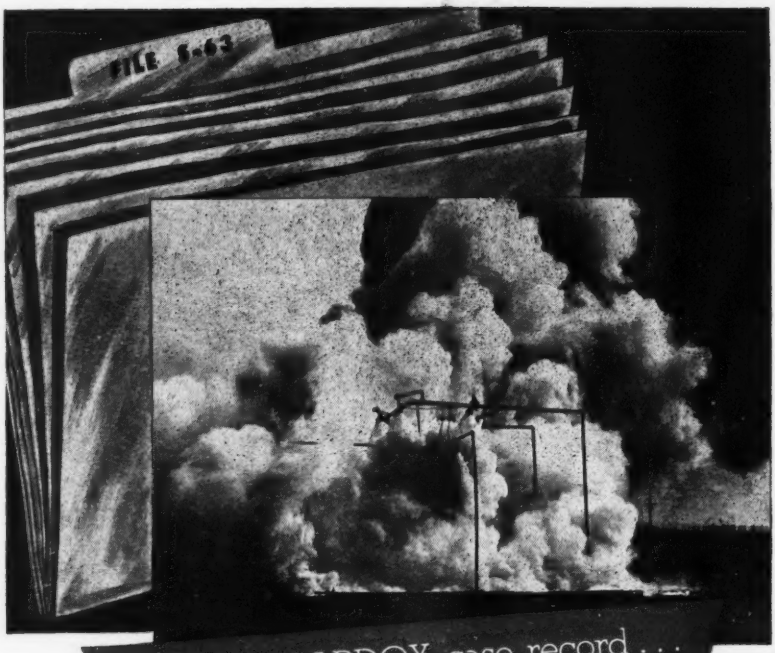

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"The fire occurred in the outdoor transformer area. It was caused by a short in the 2500-volt bus section and quickly ignited a protective screen above the busses. This protective screen consisted of burlap, rubber sheeting and plywood.

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QUARTERLY

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NATIONAL FIRE PROTECTION ASSOCIATION

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Accounts of fires appearing in the Quarterly are copies of or extracts from reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Subscriptions to the QUARTERLY are accepted only as a part of the general publications of the Association which are sent to members. Associate membership is open to anyone interested; annual dues $10, of which $5 is for subscription to the QUARTERLY.

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Syracuse Herald-Journal.

Closed sprinkler valves and an obstructed pipe contributed to this $500,000 fire loss in a Syracuse, N. Y., foundry on April 6, 1945. Only through frequent inspection and conscientious maintenance can the effectiveness of fire protection equipment be assured. **(See report on page 58.)**

The Quarterly

Vol. 39 July, 1945 No. 1

10,000 Members The total N.F.P.A. membership on the morning of June 26, the day of the "legal" annual meeting of the Association, stood at 10,034. Thus the goal of 10,000 members has been reached and a new goal of 20,000 or 25,000 members lies before us in the not too distant future. Many members have contributed towards the substantial increase in the size of the Association in recent years. Chairman H. E. C. Rainey and members of the Membership Committee have done an outstanding piece of work in calling the attention of the advantages of N.F.P.A. membership to an ever widening group. This effort, however, is by no means limited to the Membership Committee. All of the members of the Association can and most do contribute by telling prospective members about the activities of the Association.

Mere size of an organization is not of itself important, but in the case of the N.F.P.A. the influence that we can exert towards decreased fire losses is in direct proportion to the number of our members, for each Association member is a point of radiating influence in the campaign of public education in fire prevention. Furthermore, as the Association grows, each individual member benefits, as with a larger membership there come economies in production of the Association's literature and in various phases of the administration of our affairs which make it possible for the same membership dues to give greater service to each member.

Who are our 10,000 members? They represent a broad cross-section of organizations and individuals in every walk of life who are interested in doing their part towards preventing loss of life and property by fire. Originally formed by a small group of fire insurance men, the Association in its early years had as its primary if not sole purpose the development of standards for insurance purposes. The far-sighted founders of the Association, however, soon realized that fire protection is far broader than fire insurance. The Association gradually developed in an ever widening field. An analysis of the total membership of the Association as of June 26, 1945, classified in broad groups in accordance with the interest of the members, is as follows:

Fire chiefs, fire marshals, building inspectors and other governmental groups	3,026
Manufacturers, retail and wholesale business, etc.	2,947
Fire insurance engineers, companies, agents, organizations	2,464
Manufacturers and dealers in fire protection equipment	708
Public utilities	339
Chambers of Commerce, trade and professional associations	223
Architects and engineers	154
Libraries, universities, colleges	92
Unclassified	81

* * * *

The Annual Meeting Published as Part II of this QUARTERLY are the Proceedings of the 49th Annual Meeting. As the printed record shows, this was a "legal" annual meeting attended only by members of the N.F.P.A. Board of Directors, chairmen of committees having reports to present, and members of the N.F.P.A. office staff. This is the first year in our 49 years of existence when it has

not been possible to hold the regular annual meeting, furnishing a free and open forum for discussion of all fire protection problems and giving all those interested an opportunity to voice their opinions on committee reports proposing the adoption of new standards of the Association or the amendment of existing standards. Wartime restrictions on meetings and travel prevented the holding of the regular meeting, but the Directors felt that the war situation should not be permitted to interfere any more than absolutely necessary with the conduct of the regular affairs of the Association, so the "legal" annual meeting was held. No final action was taken on any controversial matter where there seemed to be any substantial difference of opinion among the members, nor was final action taken on any matter of which the entire membership had not had previous notice. As a result of advance circulation of committee reports, a few dissenting ballots were received. These were all duly considered and in certain cases action was taken to refer reports back to committees for further consideration, even though objections had been recorded by only a very few members.

* * * *

New Materials Rapid developments in all sorts of new materials, plastics and synthetic products of various kinds, present a challenge to the fire protection fraternity to familiarize themselves with various new materials as they come into use, evaluate the relative fire hazards, and develop the precautions necessary for the safe use of new materials. There should actually be no cause for alarm, for while some new materials may have unusual burning characteristics others may be even safer than the natural products which they replace, and while these new products may require detailed attention on the part of fire protection engineers, there seems to be no reason to believe that in the main their use will involve a fire hazard any greater than that of older commonly used materials once the properties of the new materials are fully understood and proper precautions taken where needed to guard against fire hazards. In the case of plastics, there is only one, pyroxylin, which has any unusual fire hazard and this is not new. Other more recently developed plastics have burning characteristics similar to ordinary combustible materials such as wood or paper, and some plastics are practically non-combustible. In the case of fibres, the synthetics appear in general to have no more rapid burning characteristics than cotton. Synthetic oils, solvents and refrigerants present no essentially new problems in fire and explosion prevention and some of the new synthetic materials actually represent a contribution towards fire safety in that they have a lesser degree of hazard than older materials which they may replace.

In the immediate postwar period, many new materials developed during the war for military purposes will be finding their way into civilian uses. In many cases they will perhaps be introduced by men unfamiliar with the importance of fire safety, and unless guidance is provided in the fire protection fraternity may be the cause of increased fire hazard. On the other hand, there is no reason for undue concern if all those responsible for fire protection will watch new developments and will furnish leadership in constantly stressing the importance of fire prevention and fire protection during the formative period in the general use of new synthetic products.

Meeting of Board of Directors.

Hotel Statler, Boston, June 26, 1945.

Present.

George W. Elliott, Chairman
Richard E. Vernor, President
C. C. Johnson, Vice-President
E. O. Shreve, Vice-President
D. J. Price, Past President
Alvah Small, Past President

A. L. Brown	H. E. Newell
Frank Epps	C. W. Pierce
Russell Grinnell	H. E. C. Rainey
W. F. Hickey	A. H. S. Stead
H. L. Miner	Lloyd T. Wheeler

John L. Wilds

N.F.P.A. Staff: Percy Bugbee, General Manager; Robert S. Moulton, Technical Secretary; Warren Y. Kimball, Engineer; Charles S. Morgan, Engineer; Beatrice L. Finley, Chief Clerk; and Phyllis L. Barbier, Assistant to Technical Secretary.

Guests: Hylton R. Brown, Chairman, Committee on Dust Explosion Hazards; A. L. Cobb, Chairman, Committee on Special Extinguishing Systems; E. Jay Hogan, Chairman, Committee on General Storage; and A. G. Smith, Chairman, Committee on Field Practice.

Business Transacted.

1. In accordance with the recommendations of the annual meeting, the following officers of the Corporation were elected for the year 1945-46: President, Richard E. Vernor; Vice-President, C. C. Johnson; Vice-President, E. O. Shreve; Secretary-Treasurer, Hovey T. Freeman; Chairman Board of Directors, George W. Elliott.

2. The Advisory Committee for 1945-46 was appointed as follows: George W. Elliott, Chairman; E. O. Shreve, Richard E. Vernor, C. C. Johnson, Hovey T. Freeman, C. W. Pierce.

3. Messrs. Russell Grinnell and C. W. Pierce were selected to complete the Nominating Committee for 1946.

4. It was voted tentatively to hold the 50th annual meeting in Boston, subject to any change necessitated by war conditions or government regulations, final decision as to the place and dates of the meeting to be deferred until the January, 1946, meeting of the Board.

5. The Chairman of the Board was authorized to appoint the Program Committee for the 1946 annual meeting, including the President, the Chairman of the Board, the General Manager, and such other members as may be deemed appropriate in view of future developments. It was agreed that, conditions permitting, the program of the 1946 annual meeting should include fitting commemoration of the development and progress made by the Association during the first 50 years of its existence.

6. The Budget for 1945-1946 as recommended by the Finance Committee was discussed and approved.

7. On behalf of the Finance Committee, the General Manager reported consideration given to date on the establishment of a retirement pension plan for the office staff. After discussion it was voted to request the Finance Committee to consider the matter further and present a specific plan for the consideration of the Board at its next meeting, subject to the provision that the current expenditure of the Association for any retirement pension plan should not exceed 15% of the annual budget for salaries. Various suggestions as to details made by members of the Board were referred to the Finance Committee for consideration.

8. Chairman Frank Epps of the Committee on Long Range Planning presented a progress report outlining the matters discussed by this committee, including consideration of methods of securing increased public acceptance of the work of the N.F.P.A. on the part of industry and others, the desirability of holding regional meetings of the Association, the importance of increased attention to the international aspects of the N.F.P.A. activities, and the possible advantages to be secured from a survey of the opinions of the membership of the Association relative to policies, procedures and lines of activity. The report was accepted and the General Manager was requested to secure information

Woonsocket, R. I., Call.

Rubber products and other materials important to the war effort were destroyed in this $400,000 fire in Woonsocket, R. I., on May 27, 1945. Automatic sprinkler protection for manufacturing buildings had been discontinued. Forty hose streams were used but could only protect surrounding property.

as to the costs and probable advantages of a survey of the opinion of the membership, reporting thereon at the next meeting of the Board.

9. The General Manager reported on the Public Relations Committee created since the last meeting in accordance with the action of the Board, indicating the character of the membership, the current activities of the committee, and the constructive service already rendered in advising the executive staff on public relations matters.

10. The Committee on Technical Committee Procedure presented the following reports:

We recommend confirmation of the technical committee appointments on the list submitted to the Board with the agenda for the meeting.

The Regulations on Technical Committee Procedure provide (par. 14) that committee members shall be subject to annual reappointment and that those who have not attended meetings or have otherwise shown lack of interest in committee work may not be reappointed. In view of the war situation, we recommend that this provision be waived for this year and that all present committee members be reappointed for the year 1945-46, with the exception of those who have resigned or have been replaced.

We request the customary authority from the Board to make additional committee appointments prior to the printing of the 1945 Year Book, subject to confirmation by the Board at its next meeting.

The several requests for additional representation on the Electrical Committee which were referred to us by the Board at the last meeting involve various questions of policy and have been the subject of extensive consideration. We recommend that no change be made in the organization of the Electrical Committee until after completion of the present revision of the 1940 edition of the National Electrical Code, on the ground that any change in organization at this time would interfere with the regular procedure of the committee in developing the next edition of the Code. We believe, however, that some changes in the structure of the committee are desirable, and will continue our consideration of this matter and submit a further report at a subsequent meeting of the Board.

After consideration of a request from the Committee on Special Extinguishing Systems for instructions relative to their jurisdiction, we recommend that this committeee be advised that it is within their province to consider water spray or so-called "fog" nozzles used on hose lines on the same basis as when used on fixed piping systems.

We have considered a request from the present Chairman of the Committee on Signaling Systems and Thermostats asking instructions as to the extent to which his committeee should consider the use of radio as a means of fire department signaling. We recommend that this committee be advised that the present wording of their scope statement which in part reads: "electrical systems and other equipment for the transmission of signals," may properly be construed to include radio as well as wired circuit systems.

C. W. Pierce, Chairman
A. L. Brown — H. L. Miner
George W. Elliott — H. E. Newell

It was voted to adopt this report, including approval of the several recommendations made therein.

11. The committee appointments recommended by the Committee on Technical Committee Procedure and by the officers were confirmed and the existing members of all technical committees except those who have resigned or have been replaced were reappointed for the year 1945-46. (Revised committee lists will appear in the 1945 Year Book to be published as Part II of the October, 1945, QUARTERLY.)

12. The General Manager reported on war activities on the part of various members of the N.F.P.A. staff.

13. Consideration was given to a communication suggesting that the N.F.P.A. join with other organizations in sponsoring a commercial standard on a method for testing the relative flammability of textiles used in wearing apparel. It was voted not to participate in the development of the present proposed commercial standard on testing methods, but that the Association should continue to keep in close touch with all developments in this field and that the Executive Office staff be authorized to render to the various organizations currently active in this field such assistance as may be practicable, and further to keep the membership of the Association advised in respect to all significant developments in this field.

Postwar Municipal Fire Protection.

By Percy Bugbee,
General Manager, N.F.P.A.

The devastating use of incendiary bombs and flame throwers in wartime has emphasized the destructiveness of fire. Severe industrial losses on the home front have resulted from great concentrations of values, speed up of production, the use of untrained employees, and the erection of large and poorly constructed buildings of huge areas which are inadequately protected. In war time people seem to have a "take-a-chance" philosophy which encourages serious fire losses. A favorable factor, however, has been the education of millions through civilian defense activities in at least the elementary principles of fire waste control. What are some of the lessons cities can learn from this wartime experience and what should municipal officials do now to prepare for the postwar years in the fire field?

Reduce Conflagration Hazard.

The use of fire as a major weapon of this war has demonstrated that whole cities can be wiped out by fire unless they have been built to resist fire and conflagration by proper spacing of buildings and by good construction. The great majority of present-day American cities are much more vulnerable to fire destruction from air attack than are the cities of England or continental Europe. Areas of American cities that are rebuilt after the war should contain wider streets, more parks and other open spaces. More space between buildings and groups of buildings tends to make cities more livable and also makes bombing attacks by hostile air forces too expensive and too inefficient to make them worth while.

The increase in the number of parking lots is a step in the right direction from the point of view of fire control. Likewise, the condemnation and removal of obsolete structures which have outlived their usefulness and which are a constant menace as fire breeders is most worth while. This sort of activity might be valuable as a means of providing quick employment for returning veterans. Along with this removal of obsolete structures should go a program of removal, replacement, or repair of all wartime temporary construction. Under the exigencies of the emergency many buildings have been erected without proper regard to the established standards of fire safety. This type of structure should receive immediate attention in the postwar period if serious fires are to be averted.

There have been more than one hundred serious conflagrations in the United States in the past 30 years, principally because of congested areas of poor construction, widespread use of wooden shingle roof coverings, and failure to protect serious fire exposures between hazardous buildings. Long-range programs designed to eliminate conflagration possibilities in cities not only will make the country safer in possible future wars, but are sound city planning at any time.

Postwar planning for fire control should include studies of existing water supplies and the possibility of providing additional static supplies for emergency use. The British have made effective use of the static water supplies scattered through their cities for the protection of important isolated industrial properties. In this country perhaps too much faith has been placed in municipal water systems to supply the necessary water under any and all emergency situations.

Building Construction and Fire Safety.

New developments in building construction undoubtedly will appear with great rapidity in the postwar period. There is much that cities can do in the direction of fire-safe and economical building construction, utilizing all present and

new types of construction materials in accordance with their respective suitability for their intended uses. Some construction materials which at present have properties making them unsuitable for certain uses may well be utilized under new and modern techniques without sacrifice in fire safety.

It is well to observe that the fire safety of a building does not depend alone upon its construction. Much more attention should be given to the combustibility of the contents and interior finish of buildings and to the arrangement and subdivision of combustible materials. All fire protection engineers recognize the efficiency of automatic sprinklers, fire alarms, and first-aid fire extinguishing appliances. Many cities could be made much safer against fire and conflagration by a sympathetic and encouraging attitude on the part of city administrators toward the protection of individual properties. For example, it appears that the officials of cities which levy a special annual charge or tax on buildings protected by automatic sprinklers have failed to realize that the owner of such a building is helping to protect his community.

A reduction in the fire and life hazard of public buildings, such as schools, hospitals and asylums, should be an immediate postwar aim. It is hard to understand why so many cities and states are willing to house children or the aged and infirm in places that are seriously deficient in even the simplest forms of fire safety. A number of states, notably California and New York, have already taken steps to make an intelligent survey of public institutions and to prepare and carry out a plan for their improvement from the fire safety point of view. Other states and cities should most certainly undertake similar activities.

Building and Fire Prevention Codes.

The modernization of local building and fire prevention laws is of real importance in postwar planning. The cause of fire safety could be greatly advanced by the elimination of obsolete and unnecessarily restrictive laws now on the statute books, and the enactment of fire safety legislation appropriate to modern conditions, covering all matters in need of regulation in the public interest. Such action by cities will help secure proper fire safety with a minimum of inconvenience, expense and interference with business and other activities. Far too few municipal administrators realize the beneficial effect that sound building code requirements may have upon the safety, appearance and general welfare of the community. It is generally preferable for a city to retain an impartial outside expert to handle the drafting of a building code or revision of an obsolete code than to load the job on an already overworked city building inspector or on an unpaid committee of architects and engineers.

There has been a good deal of confused thinking about the lines of demarcation between building laws and fire prevention codes. The building law, administered by the building department, concerns itself primarily with structural safety, whereas the fire prevention code, administered by the fire department, concerns itself primarily with the hazards found in buildings. In some cities the building department has jurisdiction over installation of fire extinguishing equipment, while in others the fire department has this authority. In either case close cooperation between the two departments is essential. Comparatively few cities have fire prevention codes in effect, and in many cities one of the most important steps that can be taken in the fire field is the adoption and enforcement of such a code.

The Fire Department.

It is possible in this article to refer only briefly to some aspects of fire department facilities and services which will require attention after the war.

Personnel.

While there will be "vacancies" to fill after the war in many cities, several factors will make possible the more effective use of fire personnel, and in some cases enable the city to operate with fewer men than

Dayton, O., Journal.

The Dayton, Ohio, municipal skating rink burning on April 24, 1945. This half-acre frame building, lacking any barrier to the spread of fire, burned just as fast as might have been expected. Fire department hose streams, particularly when the water supply is limited, cannot control such a fire once it is well under way. Loss $42,000.

such a fire once it is well under way. Loss $42,000.

Waterloo Daily Courier.

The Independence, Iowa, Fire Department had "fought the fire on the blackboard" for years before it finally started near the projection booth of a motion picture theatre on March 3, 1945. However, despite advance planning by an efficient fire department, it was impossible to stop the spread of fire through the wooden interior of the building. Loss $300,000.

before. The two-way radio, which will be made more readily available to fire departments, will enable a city to use a larger number of firemen for inspection work and other activities without serious delay in response to alarms. Elimination of nonessential positions and special details should also make more men available for regular duties. For example, there is no need to have two grades of chiefs (deputy chiefs and district or battalion chiefs) cover the same territory and do largely the same work. Where such officers are required to respond to first alarm calls in a given territory, considerable confusion results from each giving orders to various company operating units. In other words, in some cities district chiefs are a luxury; official papers and orders from headquarters can be transmitted directly to the operating units by teletype, radio or even by mail. Such a plan would also result in freeing for active duty those firemen who act as daily messengers to carry routine papers between companies and headquarters.

Fire Stations.

Fire departments in many cities could operate more effectively with fewer stations and at the same time meet the requirements of the underwriters. Instead of exploring the advantages of consolidation, however, most cities have retained many poorly manned stations set up on the basis of horse-drawn equipment. The officials of such cities could benefit from a study of the experience of cities which have been successful in reducing the number of stations and in improving fire defenses. A department that modernizes its equipment but clings to poorly located and distributed stations will find itself seriously handicapped.

Equipment.

It seems likely that after the war fires may be extinguished without the great water damage that generally occurred in the past when apparatus of large pumping capacity was used in high value areas. This will be done mainly through the use of fog equipment which has proved so highly effective during the war. Pumping assemblies will break the water into fine sprays for the rapid absorption of heat units, thus reducing temperatures of combustibles below ignition points without waste of cooling capacity.

Through the proper use of specifications cities can purchase standard apparatus instead of incorporating fancy special equipments which in many cases almost doubles the cost of the equipment. Many cities are using obsolete apparatus because the fire chief has preferred to use all available funds to buy one or two pieces, while the same money could have furnished a steady flow of needed replacements. All cities need to adopt a replacement schedule or budget for apparatus.

Another matter in connection with equipment which many cities might do well to investigate is the type used in various parts of the city. There is no need to use heavy and unduly expensive fire apparatus in light hazard areas where the actual amount of fire duty is comparatively light. Companies in outlying residential areas of cities should be equipped with comparatively light-weight, speedy, commercial truck-type pumpers which meet all of the underwriters' requirements at a reduced cost.

The use of improved equipment, such as water tank apparatus, automatic ladders, and 1½-inch hose does away with the need of having four to six men handle a single hose stream.

Fire Prevention.

While police departments have taken advantage of the radio and have put men out on patrol duty, most fire departments continue to use only about 2 per cent of their manpower on fire prevention work and hold 98 per cent in the station house waiting for fire alarms that could be prevented through more intelligent use of manpower. Some fire departments that have put more men out on inspection work have reduced the number of calls by some 50 to 75 per cent, and at the same time have arranged schedules so that there is no delay in answering alarms. In most cities at least half of the fire fighters could be doing constructive fire prevention work each day. The prevention of fires is a relatively much more useful and efficient fire

department function than the extinguishment of fires.

Considerable work could be done in most cities in encouraging fire prevention activities by adopting the principle of holding responsible the person who has a fire resulting from carelessness. Another way to prevent fires from carelessness is through the education of children in the simple precautions necessary to prevent fire. There is no lack of good educational literature available for schools and colleges but many schools throughout the country still ignore the subject. Fire prevention education is an important item in planning for fire control.

Perhaps the most effective way of preventing fires is through a regular dwelling inspection program because by far the largest number of fires occur in homes. In several hundred cities the inspection of homes by firemen is carried out once or twice a year at no increased expense to the taxpayers and with remarkable returns in reduced hazards and losses and in increased good will to the fire department. Every fire department of any size should plan to undertake a home inspection program on a regular basis.

Intermunicipal Arrangements.

After the war there will probably be greater integration of fire protection facilities in metropolitan areas. Arrangements between two or more municipalities for the more effective use of available fire fighting resources are desirable to coordinate all equipment within any area to prevent possible conflagrations and to avoid unnecessary expense in personnel and equipment. The dispatch of apparatus by municipalities to communities beyond its boundaries, known as "outside fire service," is a one-way rather than a reciprocal arrangement, and there seems to be a recent tendency for cities providing such service to place it on some sort of contract basis with a specific schedule of charges. Another type of cooperation known as "mutual aid" works both ways with the communities in the contract agreeing to help each other during times of distress. Mutual aid between fire departments is well recognized and has worked extremely well in certain areas of the country. Only through cooperative arrangements will many smaller communities receive the benefits of good fire protection service. It is possible that war emergency fire fighting equipment may be allocated to unprotected rural areas after the war.

Total Fire Defenses.

The premium rates charged property owners by fire insurance companies are governed in part by the quality of the fire protection service as determined in the cities of over 25,000 population by engineers of the National Board of Fire Underwriters and in smaller cities by rating agencies. Municipal officials should make certain that everything reasonable has been done to get the best possible grading of the city's defenses and the lowest insurance rates.

Conclusion.

After World War I there was a sharp increase in fire losses largely caused by an increasing number of fire hazards and lack of sufficient means of control over them. Combustible and volatile materials and new devices of a hazardous nature were put on the market faster than suitable safeguards could be devised and enforced. This experience may be repeated after this war, and municipal officials are responsible for anticipating fire hazards in their communities and for planning methods of fire control. Increased emphasis should be placed on fire prevention work, on the better distribution of men and equipment, on the more effective organization of the department and on improving the city's fire protection services. City officials should know what factors in the grading schedule have been most neglected by the city and what the National Board or rating bureau engineers say the city should do to get an improved grading. Many cities will need to revise their building codes and adopt and enforce fire prevention ordinances. Now is the time for the chief municipal administrator and fire chief to prepare a long-term postwar plan for improving fire protection services and reducing fire losses.

Official Photo U.S.A.A.F.

Oblique photograph, taken from a B-26 Marauder, shows the German communications center of Neunkirchen ablaze following an attack by 9th Bomb Div. medium and light bombers. The town was attacked with 375 tons of incendiaries and high explosives to block roads and otherwise hamper communications to prevent an orderly withdrawal of German forces facing the Seventh Army. Reconnaissance photos later showed more than 50 per cent of the steel-producing town destroyed.

Incendiary Warfare on Germany.

By James K. McElroy.

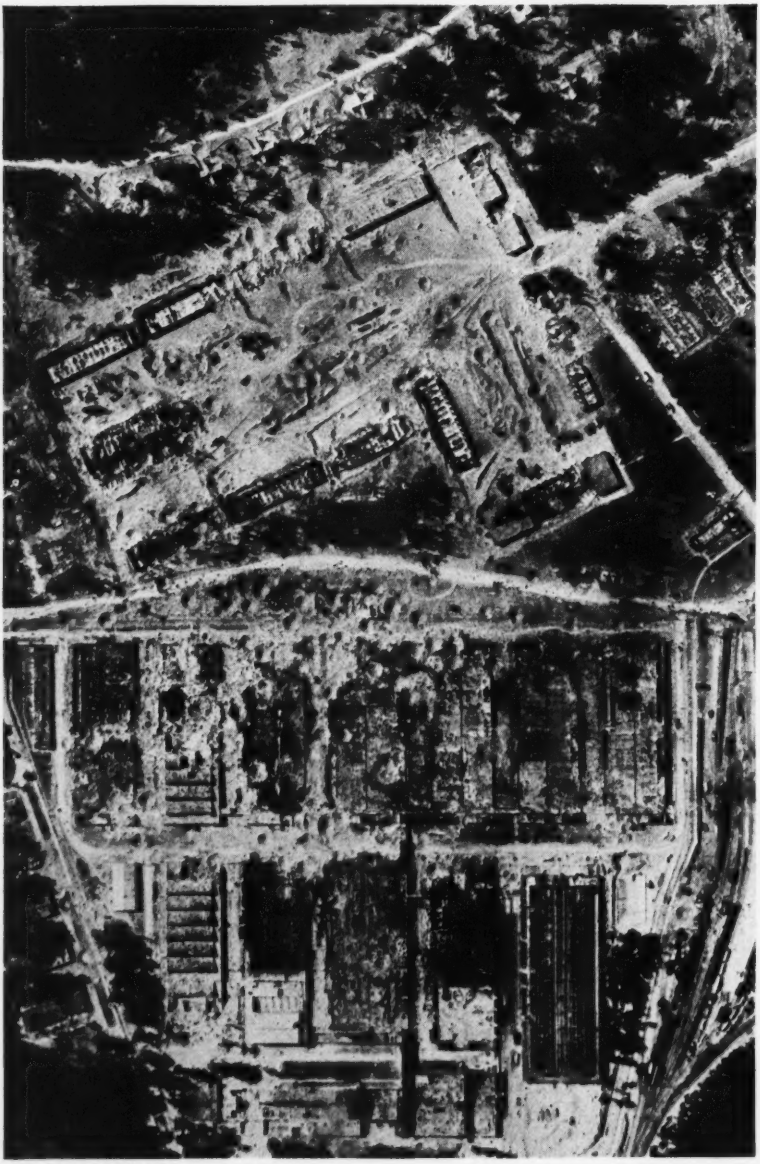
Since the German Air Force initiated the first incendiary attacks on continental and British cities, many forces have combined to produce the levels of destruction by fire and high explosive which have been attained in the strategic bombing of German industrial targets by the American Air Force and in attacks on German industrial and residential-commercial target areas by the Royal Air Force. For the first time in the history of warfare, the development of modern aircraft capable of lifting heavy bomb loads and carrying them for long distances has made large-scale fire destruction of industries and homes not only possible but predictable within reasonable limits. Aside from the loss of life which inevitably must result from the devastation now possible to produce almost at will, there are millions of the world's citizens who live and work in cities and towns within bombing range who have not yet been exposed to a reasonably scientific reduction to smoking ashes or rubble of their property and means of livelihood. The full impact of this fact on the future peace of the world has yet to be felt.

Peacetime fire engineering experience has been one of the many forces brought to bear on problems incidental to the successful effort of the Allied air forces to destroy or at the very least to immobilize in a large measure the German capacity to produce materials of war. It is obvious that in the interests of military security, the full facts regarding the usefulness of all engineering contributions in the design of air offensives cannot be disclosed. V-E Day, however, permits the publication of that part of the story of the improvement of the war-born science of destruction by air power which involves the contribution of fire engineers. Statements herein are not likely to give aid or comfort to the Japanese enemy. American fire engineers have participated in the design and testing of incendiary weapons, in the analysis of targets of all types for their vulnerability to fire, and in the effectiveness of weapons in use operationally against all types of enemy targets.

Development of Incendiary Warfare.

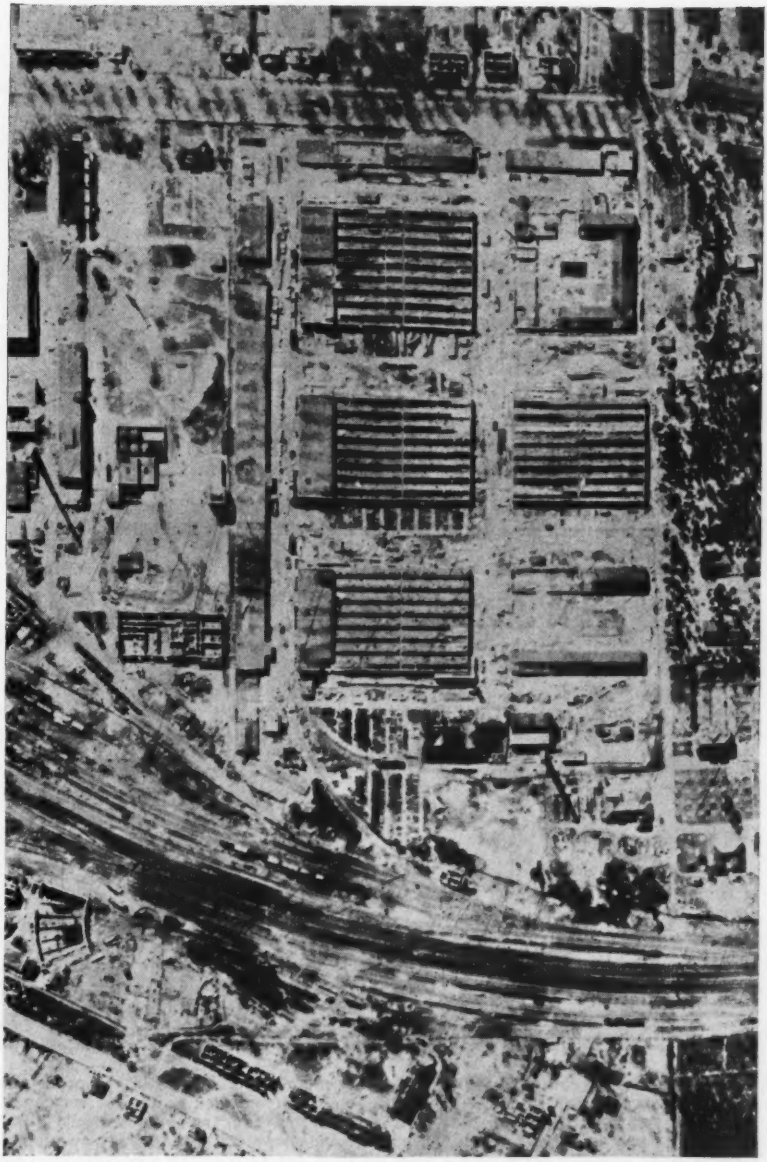
Historically, the evolution of the destruction by air power from the hit or miss methods used in the early days of air warfare to the present level of performance has been to attack, evaluate the effectiveness of attack and prepare for the next attacks by applying lessons gained from previous attacks to the new estimate of the situation. British experience with the results of early German Air Force attacks indicated that fire as a destructive agent was much more effective, weight for weight, than high explosives. Thus, the maximum use of fire as an offensive weapon in the modern sense has been a natural (though not at first an obvious) outgrowth of the British accumulation of fire damage data resulting from GAF attacks on British cities and industries since 1940.

As in Britain, the use of fire engineering experience in this country during the early war was essentially defensive. In anticipation of the threat of incendiary attack on the United States, our fire engineering profession sought knowledge of British wartime fire prevention and protection measures prior to our entry into the war, in order that adequate defensive preparations could be made here. British fire service and fire insurance organizations, many of them N.F.P.A. members, contributed much to our defensive planning by assisting American fire service officials sent to England to study fire defense against air attack at first hand. In addition, the personal friendships established through joint study of serious defensive problems were to have results of high value against the common enemy when



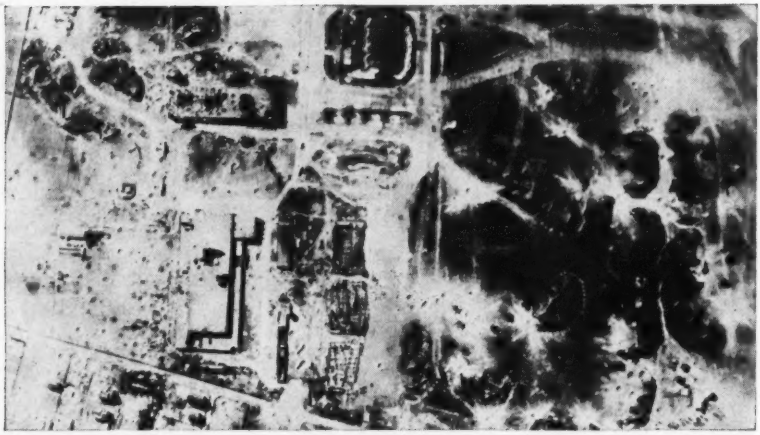
Official Photo U.S.A.A.F.

Armament and radio equipment plant. Of ten large workshops, seven were totally destroyed and the remainder three-fourths gutted at the Weimar armament and radio equipment factory, near Jena, Germany, by the U. S. Eighth Air Force bomber attack August 24, 1944. Over 50 other installations of varying sizes were damaged severely.



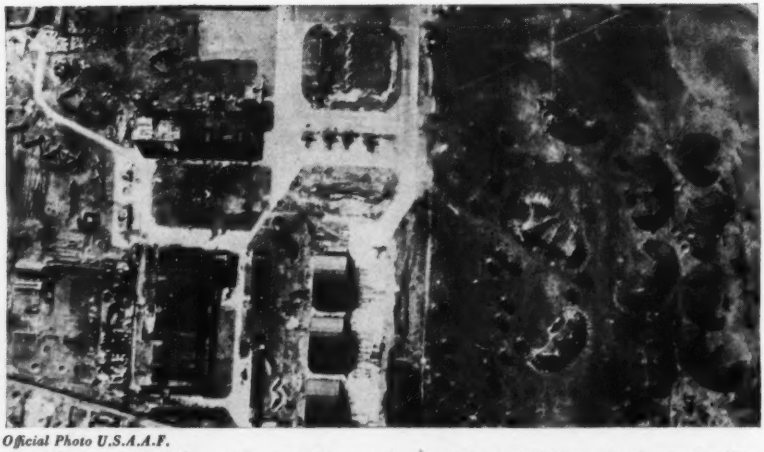
Official Photo U.S.A.A.F.

Erkner bearings hit. Varying degrees of damage are shown in this photo of the Nazi bearings plant at Erkner, a suburb of Berlin, after the daylight attack on March 8, 1944, by Liberators and Fortresses of the U. S. Eighth Air Force. Taken after most of the debris had been moved away, the picture reveals roof damage and probable interior havoc due to fire, in three large machine shops, administrative sections damaged or destroyed and other installations burned out or gutted.



Official Photo U.S.A.A.F.

Before: at Augsburg. Reconnaissance photo of important Messerschmitt works at Augsburg before attack on April 13, 1944, by Eighth Army Air Force heavy bombers.



Official Photo U.S.A.A.F.

After: at Augsburg. Severe damage to important buildings is shown in this reconnaissance picture after the Eighth U. S. Air Force attack on the Messerschmitt works at Augsburg April 13, 1944. Three round-roof hangars are destroyed; direct hits can be seen on large assembly shops, machine shops, warehouses and powerhouse. Ineffectually camouflaged concrete blast shelters are seen in the field adjoining the factory. Previously attacked on February 25, 1944, this assault was aimed at the rebuilt areas and to halt repair work.

American fire engineers returned to England to participate in the planning and evaluation of large-scale offensive use of incendiary weapons by both the AAF and the RAF.

As RAF power and, later, the power of the AAF turned to the offensive, the importance of choosing both target and weapon to produce the maximum damage to the German war effort was of paramount interest to operational air force authorities. The complex offensive problems were not easily resolved, although a mass of data from GAF attacks existed. Both American and British military and scientific authorities recognized the need for the application of peacetime fire engineering experience to their new problems. The services of American and British fire engineers were obtained; and these engineers worked in collaboration with air force operational research engineers, statisticians, mathematicians and others in an attempt to solve the problems of physical vulnerability and optimum density of weapon required to produce fire damage against German targets, which differed from the British and American in structural, occupancy and protection conditions.

The broad results of their efforts in the improvement of the use of fire as a weapon by the AAF and RAF were overwhelmingly more effective than the best the GAF was ever able to direct against Britain and are common knowledge since the end of the European war. More precise evaluation of physical target and weapon analysis effectiveness must wait for the completion of ground surveys of German industrial and industrial-residential target areas, now in process of investigation by fire and structural engineers attached to American and British bombing research missions. It is clear, however, that the application of peacetime fire engineering experience to the offensive use of fire, by whatever means induced, is profitable and valuable in the destruction of the enemy's productive capacity.

The objective of the fire engineers from the start of their work in the analysis of German targets was to assist both air forces in the production of maximum damage with the least operational effort. They hoped, by detailed analysis of the physical aspects of the target, by the proper choice of weapon and density in relation to its physical vulnerability and from aerial photographs and intelligence sources, to be able to predict with reasonable certainty the damage which would result from air attack.

The results of early RAF attacks on area targets in which industrial plants were located were convincing proof that large scale industrial fire damage by incendiary attack was possible, given vulnerability to fire in the target to begin with. When the AAF arrived in force in the European Theatre of Operations and daylight precision attack against industrial targets was possible, the use of incendiary weapons by the AAF continued to increase as the progress of the air war against the Axis demanded, and as the targets required.

AAF "precision" and RAF "area" operational methods in the European Theatre lent themselves readily to a division of the study of the effects of fire into these two categories, though many of the factors in incendiary attack encountered in the investigation and research were common to both:

1. Physical vulnerability of the structure
2. Combustibility of the contents
3. Effect of the civilian fire-guard
4. Effect of the public fire protection service
5. Effectiveness of weapons
6. Air force operational effort required

Civil fire loss experience in both England and America suggested the basic importance of the combustibility of the structure in the damage to be expected from fire. Early analysis of the physical structure of German domestic and industrial targets (largely of masonry construction) showed that the effect of peacetime German building codes (some of them 50 years old) on possible fire damage from Allied incendiary attack was to require the attacking force to compensate in weight of attack for the compartmentation of the target into fire divisions separated by parapeted masonry fire walls and air gaps. It was believed that the most important single factor in the determination of the structural vulnerability of industrial

Official Photo U.S.A.A.F.

Nazi oil burns. Flames burst through the black smoke from burning oil storage tanks and installations at the Nonheim oil refinery located between Cologne and Düsseldorf, on the Rhine River. This is the result of a U. S. Army Eighth Air Force B-24 Liberator attack.

between Cologne and Düsseldorf, on the Rhine River. This is the result of a U. S. Army Eighth Air Force B-24 Liberator attack.

Official Photo U.S.A.A.F.

Reconnaissance photo shows the thoroughgoing destruction wreaked on the Gothear-Waggonfabrik Messerschmitt 110 plant by Liberators of the U. S. Army Eighth Air Force during their raid. Damage results: 23 workshops destroyed, 14 partially destroyed, 12 severely damaged, 8 blasted by direct hits or fire, and 25 planes on the ground destroyed or damaged.

Official Photo U.S.A.A.F.

Aachen, Germany, its streets cleared of the debris and wreckage of battle, an example of the effectiveness of combined air-ground bombardment. Ninth Air Force fighter-bombers and American Artillery pounded the city until the garrison surrendered. This Ninth Air Force Reconnaissance photograph reveals the extent of fire damage in one section of the city.

buildings to fire damage was the combustibility of the roof. Subsequent analysis of fire damage to German industrial targets has proven that the original assumption was correct. Likewise, the most important single factor in the determination of the structural vulnerability of the domestic (area) target was the presence of parapeted fire walls, and large scale fire damage has resulted when attacks were of sufficient weight to offset in considerable degree the presence of the fire wall.

Obviously the "area" target offered greater structural homogeneity to the attacking air force than did the "precision" target, though combination industrial-home industry-residential target areas were very common, as in the Japanese target. In general, no two targets in either category were exactly alike. Thus, analytical effort was at first concentrated on the determination of structural building type within broad combustibility classifications (i.e., fire-resistive, non-combustible and combustible) and the size of fire division. Given the factors of combustibility, it was then possible to provide an answer as to whether or not the target under consideration might be expected to burn. It was found that most "precision" targets attacked by the AAF consisted of a mixture of structural building types. As high explosive weapons are known to be generally more effective against fire-resistive buildings than incendiary weapons, the choice of the proper combination of high explosive and incendiary weapons to produce the maximum damage to industrial productive capacity became a complex problem, which was more complex when combination industrial-residential-commercial targets were under consideration. Structural roof type is also a very important factor in the determination of penetration characteristics required of various incendiary weapons. In this connection it is interesting to note that the first British and German incendiary weapons were designed with these structural differences between the two countries in mind. Our own M-69 incendiary weapon, now in use against Japan, was carefully designed to penetrate to just the right point to do the most good in Japanese structures.

Incendiary Bomb Construction and Design.

In the design of incendiary weapons for specific purposes, great stress has been laid on the combustibility of contents of buildings in the static trials of the various weapons. Ignition of contents is the only certain method of reaching the maximum destruction of the structure. It is obvious that picking "typical" target conditions for the static evaluation of the effectiveness of incendiary weapons prior to operational use would be very difficult. In general, testing of bombs against domestic contents has properly tended to the conservative side, as it is considered impossible to reproduce in available test structures the wide range of furniture, bric-a-brac, etc., initially available as fuel to feed a fire originated by an incendiary bomb.

The contents of industrial targets varied from heavy machine operations, such as forge shops, steel mills and like incombustible contents, to paint shops, dope shops and other occupancies of highly combustible nature. Industrial fire prevention engineering experience has contributed much to the proper application of contents combustibility factors in the consideration of fire damage to be expected from incendiary attack. A preliminary analysis of fire damage inflicted by the AAF and RAF on German industrial targets indicates that the correlation between the predicted amounts of combustible contents and the fire damage initiated by incendiary weapons did, in fact, exist.

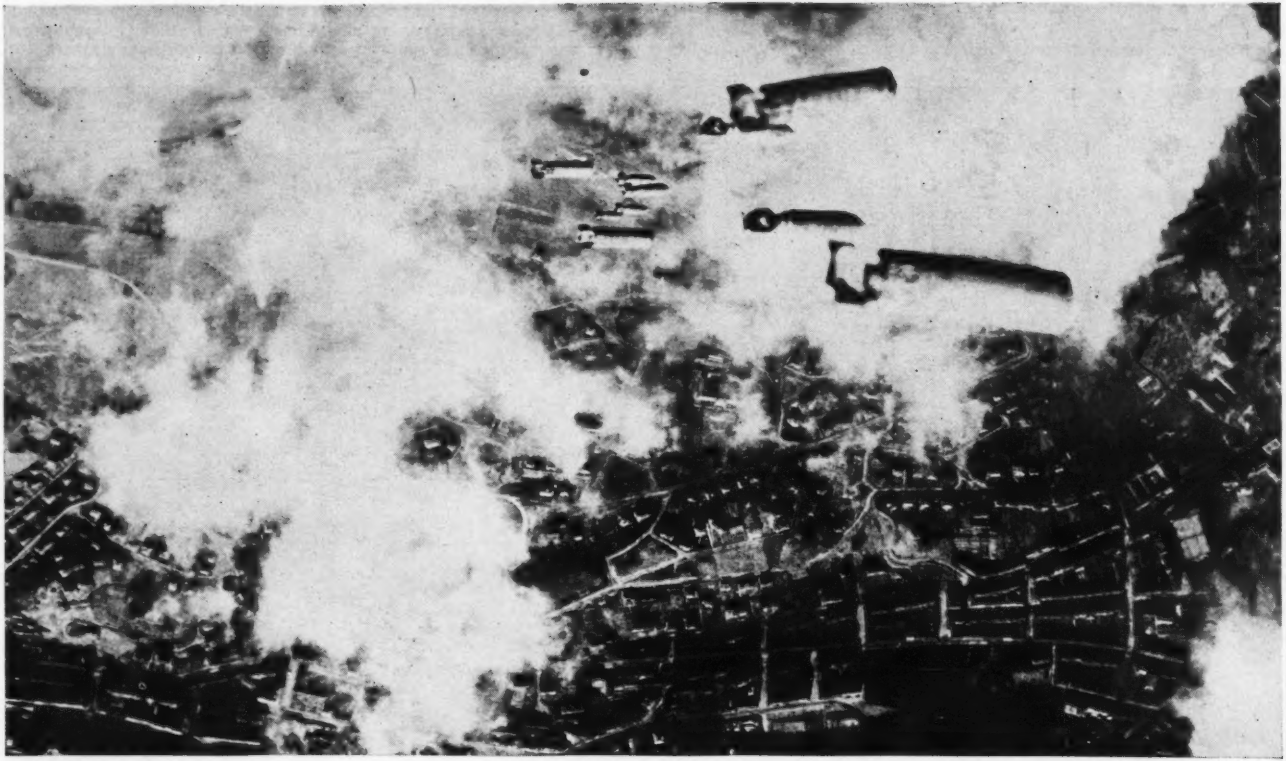
Of considerable importance to postwar fire protection engineers was the early prediction and later confirmation that there would be German industrial targets composed of a high percentage of reinforced concrete structures with occupancies having a very low degree of combustibility which offered no hope of fire damage to productive processes and thus were impervious to incendiary attack. On the other hand, contents of certain types of targets can be severely damaged by fire ignited by high explosives without the use of incendiary weapons. High levels of physical fire damage to fire-resistive structures and non-

Official Photo U.S.A.A.F.

Captured German picture of Allied bombing. Files of the captured Fieseler aircraft plant held pictures taken by the Germans of fires ravaging their factory at Bettenhausen, a suburb of Kassel, immediately following attacks by R.A.F. and U. S. Army Eighth Air Force. This shows a German soldier and a civilian surveying the scene of devastation from a tower.

Official Photo U.S.A.A.F.

Overall view, showing the damage done by the R.A.F. and the U. S. Eighth Air Force to the Deutsche Dunlop A.G. tire and rubber factory at Hanau. The widespread destruction in this plant severely cut part of the German tire production for motor vehicles. This part of the plant ceased to produce after the last air attack that left it a mass of twisted girders and rubble.



Official Photo U.S.A.A.F.

Heavy incendiary bombs, together with explosives, fall toward the city of Dresden, Germany, as U. S. Eighth Air Force heavies attack the Saxony capital following the R.A.F. night blow. Crew members of the Eighth Air Force reported fires still burning from the R.A.F. attack as the day bombers struck February 14, 1945.

combustible industrial equipment have been obtained through the use of high explosive weapons in the attack of oil refineries.

Principles of Successful Incendiary Attack.

It is now felt that to be successful, incendiary attack must overwhelm the civilian fire-guard by the use of sufficient high explosive or drive him underground for sufficient time to allow an incendiary bomb to initiate fire in contents or structure. It is certain that the fire-guard is the first enemy of the incendiary bomb, and British records are filled with heroic actions by fire-guards who saved their own and their neighbors' lives and property. Incendiary attack on home industry-residential-commercial areas limits the numbers of fire-guards effectively available to those in the areas. As most industrial targets require the combined use of high explosive and incendiary weapons for a sufficiently high level of destruction to productive machinery and equipment, the fire-guard must have even greater courage to stay in the target area to attack fires of incendiary origin in the incipient stage. Automatic sprinkler equipment, in effect a peacetime fire-guard, has no effect if sufficient high explosive is used to fracture water mains, pressure and storage tanks, electrical fire pump connections, etc. There is evidence, however, to support the view that there is high probability that sprinkler systems will control fire resulting from pure incendiary attack if water supplies are not depleted. The overall effectiveness of the German fire-guard has not yet been determined, though mass destruction of German industrial targets and cities would seem to indicate that AAF and RAF attacks have been of adequate intensity to have made his efforts relatively ineffective.

In the design of incendiary attack, some calculation must be made of the operational effort required to offset the effectiveness of the public and auxiliary fire protection service. The mutual aid features, including standardization of equipment, which made the British National Fire Service so effective during the European war, are known to have had their counterpart in Germany. Lack of water supply, rather than the number of pumps available, was considered to have been the primary factor in the early incendiary losses in Britain. There is not sufficient data available from the investigation now proceeding in Germany to make definite statements, though with the weight of AAF and RAF attack on German industrial targets and target areas it appears extremely doubtful that the German fire service was able to cope with the problem. It is to be hoped that the wartime experience of the British and the investigation of the effectiveness of the German fire services may prove useful in a determination of minimum standards and requirements of equipment, personnel and water supply distribution to handle large scale fire damage correlated with the physical fire vulnerability of various industrial, residential and commercial areas. So long as the threat of war exists and combustible building materials are in universal and economical use, no public fire protection service in the world can afford to consider itself immune from the possibility that it might have to deal with the large scale use of fire as an offensive weapon. That the cost of adequate protection against attack (if it is possible) will be tremendous is admitted. Much less money, spent to assure the future peace of the world, will relieve the fire services for improving their peacetime fire prevention and protection programs.

Following the determination of the fire vulnerability of targets and target areas, and the consideration of probable effectiveness of the fire-guard and the public fire protection is the choice of the proper incendiary weapon. The development of both British and American incendiary bombs to the point where they are in effective operational use against the enemy is a story of tedious and painstaking laboratory research and test. The Chemical Warfare Service, the Office of Scientific Research and Development and British technical agencies have worked independently and in collaboration to provide effective incendiary weapons. Contrary to the popular conception that there is a perfect all-purpose incendiary bomb, there is no bomb

Saxony capital following the R.A.F. night blow. Crew members of the Eighth Air Force rejoice also with burning from the Nazi's attacks as the day bombers struck February 14, 1945.

Official Photo U.S.A.A.F.

(Left) Berlin, Germany, before bombing. This area is immediately north of the Tiergarten on both sides of the River Spree as it appeared prior to tremendous R.A.F. night assaults in late 1943 and early 1944. (Right) Berlin, Germany, after bombing. Damage here was caused almost entirely by fire.

that does not have one or more important features which others do not. Technical research is bound to advance the knowledge and improve the design of incendiary weapons when complete weapon effectiveness data are available from ground surveys of damage in Germany. However, it is true that certain bombs now available more nearly approach universal use against a wider physical range of targets than others.

Comparative Details of U. S. Bombs.

Recent release, through military channels, of details of design of incendiary weapons at present in production makes it possible for this issue of the QUARTERLY to list U. S. bombs with part of the comparative details:

M-50—Weight, 3 lbs. 9 ozs.; weight of magnesium, 1.1 lbs.; heat liberated, 13,000 Btu.; striking velocity, approximately 475 ft./sec.; penetration, up to and including 4″ reinforced concrete; number in cluster, 110.

M-69 — Weight, 6.2 lbs.; weight of fuel (gelled gasoline, tail ejected), 2.6 lbs.; heat liberated, 44,000 Btu.; striking velocity, approximately 225 ft./sec.; penetration, up to and including 3″ concrete, not reinforced; number in cluster, 38.

M-74—Weight, 8.4 lbs.; weight of fuel (so-called "goop" mix, tail ejection), 2.8 lbs.; heat liberated, 38,000 Btu.; striking velocity, approximately 250 ft./sec.; penetration, up to and including 3″ concrete, not reinforced; all-ways fuse provided; number in cluster, 38.

M-47—Weight, 70 lbs.; weight of fuel, approximately 40 lbs.; heat liberated, 670,000 Btu.; striking velocity, approximately 760 ft./sec.; penetration, 5″ reinforced concrete; not clustered.

M-76—Weight, 473 lbs.; weight of fuel, 175 lbs.; heat liberated, 2,210,000 Btu.; striking velocity, approximately 1000 ft./sec.; penetration, up to and including 12″ reinforced concrete; not clustered.

Conclusions.

In the final analysis, the actual fire damage inflicted on the enemy must result from the delivery of the proper bombs on the target or target area. As targets differ between those familiarly known as "precision" and "area" targets, so do operational methods of attack differ. These methods are quite properly military secrets. AAF and RAF methods have been successful in all theatres of war and have immeasurably improved, as have the design and development of weapons, the analysis of targets and the choice of weapons.

Regardless of the outcome of present studies of the overall effect of Allied bombing on the German war economy, the Allied air forces have proved that joint effort by all technical engineering personnel and operational authorities can produce physical damage of terrific proportions, and in all this the fire engineering profession has played its part.

As fire protection and prevention lessons to be learned from the offensive use of fire as a military weapon become available and the security situation permits, the N.F.P.A. will continue to make available to its members through its publications the factual story as it can be unfolded to the public.

almost entirely by fire.

Fire Safeguards for Magnesium.

The rapid development of the use of magnesium during the war period has brought many new problems of fire protection. Further experience and research are needed before these problems can be fully solved, and standard practices for fire prevention and fire protection finally established. It seems desirable, however, at this time to present the information on magnesium fire protection now available, to supplement and bring up to date the information on this subject previously published.* Like other fire hazards that have been introduced with new developments in industry, there seems no reason why the fire and dust explosion hazard of magnesium cannot be controlled through the intelligent application of the recognized principles of fire safety. Magnesium, however, has involved a special problem because of its unusual characteristics, calling for modification of ordinary techniques of fire extinguishment. This subject has been considered by committees and by many members of the National Fire Protection Association and the opinion in the fire protection fraternity as to the best methods of handling magnesium and extinguishing magnesium fires is gradually becoming crystallized. It is to the best interests of the industry itself to see that the introduction of magnesium in new uses does not bring such a marked increase in fires and explosions as to interfere with the use of this inherently valuable material. Some of the leaders in the industry have already recognized the need for proper precautions wherever magnesium is employed, but there is still much to be done in this field.

The public generally regards metals as non-combustible, basing their opinion upon long-time experience with iron, copper, lead and other common metals. Magnesium has in many cases perhaps been put into use in place of some of these other metals without any realization on the part of the user that it has entirely different fire characteristics and must be treated accordingly. As a matter of fact, magnesium is by no means the only metal that will burn. Iron and steel will burn at elevated temperatures. When in a finely divided state as, for example, in steel wool, the metal iron may be ignited by a match or spark. Finely divided lead especially prepared will ignite spontaneously on exposure to the air. Magnesium thus differs from other metals not so much in respect to the fact that it will burn, but in respect to the conditions under which it may be ignited and burn. A full understanding of these conditions is essential to the safe use of magnesium in industry.

Magnesium Incendiary Bombs.

Magnesium incendiary bombs gave magnesium a degree of general publicity far greater than that accorded any other new product in recent years. In some respects this publicity may have been considered unfortunate by the industry as it tended to fix in the public mind the idea that magnesium is an incendiary material and that fires in it are attended with a considerable degree of personal hazard. On the other hand, this publicity had the advantage of familiarizing the public with the existence of magnesium, giving a healthy respect for fire and fixing in the minds of thousands of air raid wardens the idea that while burning magnesium is a special type of fire, it is not difficult to control if attacked promptly by any one of

*Previously published articles in the QUARTERLY dealing with magnesium include the following: "Magnesium and Its Alloys," H. S. Hirst and A. B. Guise, October 1940, p. 125; April 1941, p. 374; "Pitch for Extinguishing Magnesium Fires," Hylton R. Brown and Irving Hartman, January 1942, p. 226; "Tests on Large Magnesium Fires," January 1945, p. 219.

Members have also had available upon request "Report of Tests on Control of Magnesium Fires with Sprinklers," issued in September 1944 by the Factory Insurance Association and the National Board of Fire Underwriters.

a number of different extinguishing methods. Recent tests and experience indicate that magnesium fires in many cases can be extinguished by the use of water properly applied.

While some may regret the wartime publicity on the burning characteristics of magnesium, it must be recognized that this publicity has had its effects and that the industry is well advised to adopt as its public relations policy a frank acceptance of the fact that magnesium will burn. No attempt should be made to conceal the burning characteristics of magnesium, but rather attention should be focused upon proper methods of handling magnesium to minimize the possibility of the occurrence of fire and the use of proper fire extinguishing techniques in case of fire. With a full understanding of the characteristics of magnesium and with continuing research and development in this field, the fire hazard characteristics of magnesium should present no more of a problem than in the case of many other materials in common use which are inherently combustible, but which can be used with reasonable safety where proper precautions are observed.

Fundamentals of Fire Safety.

While magnesium has burning characteristics that differ from those of many other materials, the fundamental considerations are substantially the same as with any combustible material, although the penalties for neglect of the fundamentals of fire safety may be more severe in the case of magnesium. The most important single principle and the one which, disregarded, explains a large proportion of our national fire waste, is the elementary conception of subdividing materials so that in case of fire the amount of fuel at any one location will be limited. This is not merely a question of not putting too many eggs in one basket. It is also a matter of not having too much fuel in one place which if ignited might cause damage elsewhere. The tendency in modern industry is towards increasingly large-scale operations, and unless watched from the point of view of fire safety this is very apt to lead to placing too much combustible material in a single building subject to one fire. If the thought of separation of combustible materials into reasonably small units is constantly kept in mind, it is almost always possible to achieve this objective without any undue interference with mass production methods.

Any combustible material will ignite and burn more readily when in a finely divided state than when in a solid mass. A familiar example of this is ordinary wood which will burn very readily in the form of shavings but is difficult to ignite when in the form of a large timber. When the wood is pulverized, as in the case of wood flour, it is subject to dust explosions when mixed with air. Magnesium has exactly the same characteristics as apply to practically all combustible materials.

Magnesium differs from most combustible materials in respect to its heat conductivity, which affects the relative ease of ignition. To ignite any material, it must be brought up to its ignition temperature by some heat source. In the case of magnesium, the high heat conductivity tends to carry away heat from any point exposed to a small flame or other source of heat and retard the development of high temperatures in the metal. This explains the difficulty of igniting any large piece of magnesium by a small source of heat.

Combustion calls for three conditions — a temperature high enough to cause ignition and maintain burning, a supply of oxygen and, of course, a supply of the combustible material as fuel. Fire may be extinguished by eliminating any one of the three links in the chain, that is, by cooling, smothering, or removing the combustible material. In this, magnesium follows the pattern of other combustible materials, but differs from ordinary materials in that its affinity for oxygen is so great that it can take its oxygen for combustion from water or from other materials containing combined oxygen as well as from air. When the oxygen from water combines with magnesium, hydrogen is released which furnishes additional fuel. It is this property of magnesium which complicates the extinguishing problem,

but these difficulties can be overcome either by smothering with specially prepared materials which are substantially inert to magnesium, or by cooling with water applied at a sufficient rate so that heat is taken away by the water faster than it is generated in the combustion, thus decreasing the temperature of the burning metal to the point where the fire eventually goes out. Incidentally, magnesium and various other materials can burn in an atmosphere of chlorine just as in an atmosphere of oxygen, and burning magnesium will remove combined chlorine from various compounds just as it will remove oxygen from water. This explains why carbon tetrachloride is not a suitable extinguishing agent for magnesium fires. Similarly, magnesium can burn in an atmosphere of carbon dioxide, and under fire conditions will combine with nitrogen. Thus the common forms of inert gas protection are not effective for magnesium.

Many finely divided combustible materials in the presence of a certain amount of animal or vegetable oil and moisture will heat spontaneously, the heating under certain conditions gradually building up to the point of ignition. The spontaneous heating of fine magnesium scrap is thus not essentially different from the spontaneous heating of a good many other common combustible materials, except that the high heat conductivity of magnesium is a favorable factor tending to reduce the spontaneous ignition hazard.

Good housekeeping is one of the most important of all fire prevention measures, and is absolutely essential wherever magnesium is stored or handled in any form. Good housekeeping includes immediate removal of waste and all unnecessary combustible materials, orderly procedures in storage and handling of all materials in process, and proper maintenance of all equipment. If combustible packing materials are allowed to remain in the building, they may furnish the kindling to ignite magnesium parts which by themselves would not be ignited by matches, carelessly discarded smoking materials, chance sparks or other small sources of heat. Many other standard measures of fire prevention and fire protection are applicable to buildings where magnesium is stored and handled, just as in the case of any other occupancy, but it is not within the scope of this article to discuss such general features which are covered in detail in the various publications of the National Fire Protection Association and which should be a matter of general knowledge.

Magnesium Dust.

Magnesium, like aluminum, when in the form of dust, presents the most acute hazard. It is subject to particularly violent dust explosions, and where there is any quantity of magnesium dust in suspension in the air any incipient fire is likely to result in an immediate explosion with no opportunity for fire fighting. The problem of magnesium powder or dust has been considered in detail by the N.F.P.A. Committee on Dust Explosion Hazards, which has developed a comprehensive code for the prevention of explosions in magnesium powder or dust.

Ordinary type dust collectors should not be used for removing magnesium dust. A special dust collecting system should be employed which utilizes a water spray nozzle to knock down the dust so that it can be carried away as a sludge.

It is of particular importance that the dust particles be wet by a spray as close to the grinding wheel as possible. Dry ducts leading to a water wash collector are extremely hazardous from the explosion standpoint and present a severe hazard to personnel if more than one grinding wheel is connected to one duct.

Good ventilation should be provided to remove the hydrogen which is formed. The sludge should be collected in drums and frequently disposed of by mixing with about 4 or 5 parts of weight of sand or dirt and burying in a dump, or by burning under carefully controlled conditions in a safe location. The sludge should not be allowed to stand in the half-wet condition, as a reaction between the magnesium and water might cause the temperature to rise to a point where ignition could occur. The amount of magnesium alloy involved and the hazard connected with the grinding

process do not warrant attempts to reclaim magnesium dust.

Grinding wheels for use with magnesium and its alloys should not be used for other metals, and frequent cleaning around the grinding operation is essential to prevent accumulations of dust.

Machining Operations.

The most important single recommendation in connection with machining of magnesium parts is to maintain cleanliness, remove turnings and scrap promptly, and not allow any accumulation of such waste materials to remain around the machine, for to do so invites fire. If a fire should occur it can usually be extinguished with little damage if there is no appreciable amount of exposed magnesium scrap or turnings in the vicinity

Most fires in connection with machining magnesium are caused by friction between the tool and the work. Keeping tools sharp, particularly on high speed finishing cuts, is an important fire prevention measure. If a cutting oil is needed, a mineral oil is preferable. No water or water emulsions should be used in machining operations.

Experience shows that automatic sprinkler systems as commonly installed in machine shops furnish effective protection and should by no means be removed when magnesium machining operations are introduced. Sprinklers on a magnesium fire may have the immediate effect of accelerating combustion, but they will keep the surroundings cool and prevent spread of the fire.

Foundries and Heat Treating.

Where foundries, die casting operations and heat treating furnaces are located in properly designed, fire-resistive buildings with nothing in the area to burn except the magnesium, fire safety should not present too difficult a problem. The principal adverse experience with fires in these processes has been where they were located in buildings of combustible construction or with wooden roofs where a magnesium fire may ignite the wooden structure. In the case of a burning wooden roof over a ladle of burning magnesium, the only effective way to attack the roof fire is with water. The water used on the roof falling on to burning magnesium will accelerate combustion and will cause a violent explosion if it falls into a ladle of molten metal, just as water in molten metal of any kind will cause an explosion. If on the other hand, the roof is of non-combustible construction, it cannot be ignited and the only problem presented is the burning magnesium itself, which should not be difficult to smother, using special extinguishing powder provided for the purpose.

In the case of heat treating furnaces, accurate temperature control is most important. The normal heat treating temperatures approach rather near to the ignition temperature of magnesium and if the heat is not properly regulated it is easy to raise castings to the ignition temperature. Uniform temperature control throughout the furnace is particularly important to prevent the development of local hot spots.

Maintenance of an atmosphere of 1% sulphur dioxide in the heat-treating furnace partially prevents ignition of magnesium alloy parts, probably by the formation of a magnesium sulphide film over the surface of the pieces. Sulphur dioxide, however, is not considered effective as a fire extinguisher for burning magnesium.

Tests made with sulphur dioxide atmospheres on burning magnesium alloy turnings showed that burning increases over the rate in still air. However, industrial fire experience indicates that 25% of the charge in a furnace may be recovered as melted scrap from the floor of a furnace which has been flooded with sulphur dioxide when the charge ignited.

For effective fire extinguishment, furnaces must be as nearly airtight as possible. Usual types of heat treating furnaces do not ordinarily come within this classification and should be given special attention before being used for magnesium. It is said that fires in reasonably tight furnaces have been extinguished by throwing a large quantity of waste soaked in high flashpoint oil on the floor of the furnace and sealing furnace openings. The gases

from the oily waste smother the magnesium fire. Bituminous coal, although never tested as far as is known, should be effective also for furnace fires and would be somewhat safer to handle than oil. One case has been reported where helium was used unsuccessfully, which was probably due to its use a considerable time after start of the fire, and a leaky furnace. Helium should be effective in a tight furnace, but until recently it has not been available in any quantity, and there has been little experience with its use. Argon is another gas, inert to magnesium, that should be effective. These inert gases are relatively expensive, but their use may be found to be well justified under some conditions.

The heat treating temperatures ordinarily are from 730° F. to 780° F., and at temperatures below the latter figure magnesium alloy castings may be held for long periods without ignition. Ignition has been reported when furnace temperatures have been in excess of 800° F.

Storage.

Although finely divided magnesium alloy will ignite readily, larger pieces such as castings and billets do not ignite except when heated for a considerable period of time to temperatures of from 800° to 1100° F., depending upon the composition of the alloy used. Accordingly, although storage of such material should be in a non-combustible building away from other more readily combustible material, storage in an ordinary sprinklered building is reasonably safe because of the probability that any fire in other contents or involving the building construction will be extinguished before there is sufficient heat to ignite the magnesium.

Fire Extinguishment.

In a basic study of the problem of fires involving magnesium or its alloys, in foundries, machine shops and warehouses, it appears that the matter of prime importance is the minimizing of damage to structures, equipment and materials other than magnesium. The extinguishing of burning magnesium is important, but it should be considered as secondary to the protection of other property.

So much publicity has been given to the danger of the use of water on magnesium fires, with the attendant production of hydrogen in a reaction of explosive violence, that there has been a general reluctance on the part of fire fighters to use water in areas where magnesium is burning, and as a result there have probably been some cases where losses have been much larger than might have occurred if water had been used with due discretion. Perhaps the most important conclusion that can now be drawn is that automatic sprinkler protection has definite value in areas where magnesium parts are being machined. While small fires in magnesium are commonly extinguished by the use of special powders provided for the purpose before there is sufficient heat to open sprinklers, sprinklers will operate if the fire is not promptly controlled by other means and protect the building as a whole. Water from sprinklers may have the immediate effect of intensifying the combustion of magnesium chips, but the fact remains that sprinklers are effective in preventing the spread of fire, and water from sprinklers absorbs heat and minimizes heat damage to machine tools. The rather spectacular effects of a water spray on burning magnesium do not by any means necessarily indicate the relative severity of the fire damage.

There has been some confusion about magnesium fires owing to the fact that there is a wide variation in the burning characteristics, depending upon the form of the magnesium. The recommendations for the handling of magnesium in one form may not apply at all to fighting fires in magnesium in some other form. For purposes of fire fighting, three entirely different situations must be considered: one, where there is a large quantity of magnesium dust present; the second, where solid magnesium parts are involved; and the third, where molten magnesium is handled in foundries.

The great bulk of the use of magnesium is where solid magnesium or magnesium alloy castings, machine parts, etc., are

machined, stored or handled. Here the hazard depends not only upon the quantity of magnesium present, but more particularly upon the size of the parts. Large magnesium castings are not easy to ignite. When burning, they can readily be extinguished by the use of water to cool the magnesium below its ignition temperature, if attacked before too large a quantity has been involved. Fine magnesium turnings, on the other hand, may be ignited readily, and under some conditions very fine material in the presence of water may ignite spontaneously. The experience seems to show that although water does have the immediate effect of intensifying any magnesium fire and may result in explosions of more or less force, this should not be allowed to interfere with the use of water in a situation where water would otherwise be applied for the extinguishment of a general building fire.

While recent tests on the handling of magnesium fires indicate that there is a difference of emphasis in respect to recommendations pertaining to the use of water, there appears to be no fundamental difference of opinion. The Chicago Fire Department in December, 1943, had an experience with fire in a magnesium foundry which was successfully handled with water. This focused attention upon the importance of securing further information for the benefit of fire departments confronted with practical problems of fighting magnesium fires in various types of war industries. Chief Anthony J. Mullaney of the Chicago Fire Department thereupon conducted a series of tests which showed to the satisfaction of the Chicago Fire Department that they should have no hesitancy in using hose streams on fires where magnesium castings or machine parts are involved. Later tests also demonstrated the possibility of controlling fires in ladles of molten magnesium by means of a fine water spray carefully applied.

A summary of these tests, as well as other experiments, is contained in a pamphlet published by the National Fire Protection Association entitled "Fighting Magnesium Fires." Where magnesium fires are promptly discovered and can be attacked in an incipient stage, there are special extinguishing agents available which have proved very successful in handling such fires without any explosive effects or incidental damage. These are the several powders consisting of graphite, pitch and certain proprietary powdered materials.

The fire problem presented by spills of molten metal from crucibles, ladles and similar containers is one which can be handled by covering with dry molding sand, which is usually readily available, or by the use of special extinguishing powders provided for this purpose. This occurrence is not uncommon in foundries and is not usually considered serious unless other combustibles are involved.

There is one favorable factor in fighting magnesium fires — the fact that the average magnesium fire (if no other materials are involved) burns rather quietly and produces no toxic smoke or gases, and thus it is often possible to approach the fire fairly closely to survey the situation and to direct fire fighting operations along the most effective lines. However, if water is present, the magnesium burns violently and close approach is impossible. Likewise, if the magnesium is burning on a concrete floor there may be spattering of the fire owing to moisture or the effects of combined oxygen in the concrete. And if the magnesium is in the form of dust a flash fire or explosion may occur before there is time for any fire fighting.

1. Main precaution is to keep chips at minimum. Workers sweep up and shovel chips into drums with tight covers (not shown here) kept at machines.

FIRE SAFEGUARDS FOR MAGNESIUM

at the Pratt and Whitney Division, United Aircraft Corporation.

Through the courtesy of the Pratt and Whitney Division of United Aircraft Corporation, we show the methods they have developed and used very successfully to prevent and control fires in magnesium.

Of special interest is the method for handling fires in small quantities of chips at machines by using asbestos powder. It should be noted, however, that this powder is not used as an extinguishing agent, but rather for its blanketing effect. Various other materials, such as sawdust-talc mixtures, clean iron filings and particularly the special commercial powders for extinguishing fires are being used in other plants.

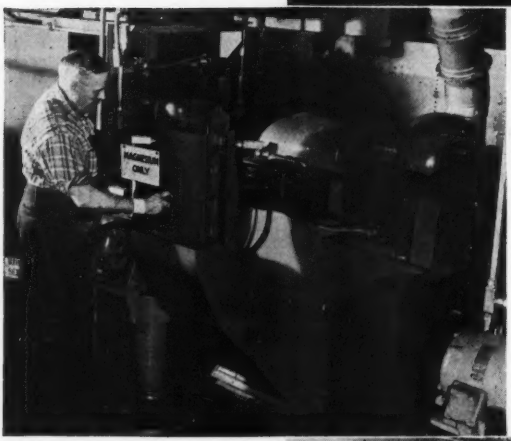
2. Drums are collected by small trucks several times a day and stored in an isolated area or in the yard until trucked away.

3. Operators are trained by the use of a dummy machine set up in yard. The burning chips make a hot persistent fire, which is covered with asbestos powder. This blankets rather than extinguishes the fire.

4. The slow-burning mixture is shoveled into a drum, which is placed on a skid and hauled away. In an indoor fire, the drum would be taken out and dumped.

5. A typical fire-fighting station. Drum contains powdered asbestos. Note skid, asbestos gloves and "keys" (used to tilt and roll hot drum on to skid) for handling operation.

6. A typical oil-cutting operation. Water emulsion oils should not be used, as chips burn more intensely when wet.



7. Smoothing a small casting on a belt sander. The dust is drawn into a water-wash collector and later removed as sludge.

8. A safe casting storage. Building is incombustible, with automatic sprinklers. Castings are stored in piles of moderate size.

Photographs—Pratt & Whitney, Div. United Aircraft—Factory Mutuals.

Typical Magnesium Fires—1942-1945.

The following list of fires involving magnesium reported to the N.F.P.A. Department of Fire Record is presented as typical of current fire experience. This is not intended as a complete record; many additional fires controlled in their incipiency by the use of special extinguishing powders or by other means have involved little or no loss and have not been reported through the usual channels. A record of prior fires was published in the Quarterly for April, 1941, page 384, and in the revised reprint of the article "Magnesium and Its Alloys," by H. S. Hirst and A. B. Guise, published by the N.F.P.A. in October, 1942.

April, 1942, Cleveland, Ohio. Magnesium Smelting.

A small fire started in the magnesium smelting building, which was of corrugated iron construction with earth floors. One or two gas heated melting pots were set on metal legs above the floor. The bottom fell out of one of the pots and contents dropped on the floor. The workmen left the building and let the material burn itself out. Damage was about $50,000.

April 4, 1942, San Francisco, Calif. Magnesium Plant.

Fire, which started from an overheated bearing on a high-speed magnesium-grinding machine, flashed through this plant, igniting magnesium dust gathered on roof rafters. The building was not sprinklered. An employee operated a public fire alarm box and firemen used eight hose streams. The fire extended through the roof, causing considerable damage.

June, 1942, Cleveland, Ohio. Magnesium Smelting.

A number of magnesium melting pots were set over one concrete pit, which contained gas and air connections and supports for pots. One pot broke and let molten magnesium into pit. There was some water in the pit, causing the magnesium to explode. Loss was considerable.

Aug. 5, 1942, Bendix, N. J. Airplane Accessory Manufacturing.

Fire occurred in a one-story brick building making instruments for planes. Employees discovered the fire in a large melting pot for magnesium when a crack developed in the pot, causing some of the molten magnesium to come in contact with the burner. A hot fire resulted but was confined to the pot. The brickwork at the pot and the electrical controls were damaged, with some magnesium lost. This pot holds about 2000 pounds of magnesium and is the largest one at the plant. A large amount of soapstone and special extinguishing powder was used to extinguish the fire. Loss: $800.

Aug. 6, 1942, Aberdeen, Wash. Magnesium Plant.

Breakdown of a grinding machine caused a part to fall on rollers, striking a spark which ignited magnesium dust, causing an explosion. Production was delayed two weeks. Loss: $5000, according to newspapers.

Aug. 7, 1942, Bendix, N. J. Magnesium Foundry.

Fire occurred in a magnesium foundry area of a one-story brick plant building where airplane accessories were being manufactured. Exact cause is unknown, but possibly magnesium dust on the racks used to place castings in oven became ignited, or oil on the bearings of the conveyor carrying castings to oven may have ignited. Fire was confined to the machine, with moderate loss.

Sept. 3, 1942, Carnegie, Pa. Magnesium Plant.

Fire occurred when magnesium billets were being pulverized in a one-story frame lean-to adjoining another plant building. It is believed that a spark from some foreign substance in the machinery ignited the magnesium. The fire department used three hose streams, but the lean-to was completely destroyed. Loss: $2670.

Sept. 22, 1942, Malden, Mass. Magnesium Plant.

A one-story frame magnesium milling shed was totally destroyed by fire which occurred when an electric spark from a vibrator ignited 180 pounds of magnesium powder. Usual difficulties in fighting a magnesium fire were encountered by firemen, who used two hose streams to protect exposures until milling shed was consumed. Hose streams were then played into burning magnesium powder until it was consumed.

Oct. 16, 1942, Buffalo, N. Y. Machine Shop.

A small fire occurred in a one-story building when magnesium shavings ignited while a small magnesium casting was being machined. Shavings were overheated by high speed of milling machine. An employee used a carbon tetrachloride extinguisher on the fire, but the blaze was controlled by application of sand kept at machine for this emergency. Damage by fire was slight.

Dec. 14, 1942, Los Angeles, Calif. Magnesium Plant.

A one-story brick and concrete foundry making magnesium alloy castings for airplanes was severely damaged by fire which swept rapidly through the building. A workman was inserting the plug of an electric drill in a socket above a work bench in the buffing and cleaning room when a sudden flash ignited magnesium dust from the buffing and grinding machines. Wired

glass windows melted from the heat. Automatic fire doors checked spread of flames to foundry and furnace rooms. Twelve hose streams were used to flood fire and protect exposures. Moulders sand was used to erect dykes to prevent water from reaching magnesium furnaces. Loss: $43,600.

Jan. 22, 1943, Carnegie, Pa. Magnesium Plant.
Experiments with magnesium in a ball mill were being carried on in the grinding and mixing room, in an endeavor to meet government specifications for magnesium powder. A ton of magnesium had been placed in the mill to be pulverized. The mill was stopped at intervals for examination. During one of these intervals an explosion occurred which blew off the roof, killing one employee and injuring three others. Volunteer fire departments were called and controlled the fire in 1½ hours with hose streams. No water was played on the burning magnesium in the ball mill, which was back in operation a few hours after the fire. The building was not equipped for such hazardous operation and cause is blamed on carelessness. Loss: $6000.

Jan. 30, 1943, Buffalo, N. Y. Metal Working Plant.
Fire occurred in a one-story concrete-on-earth building of a metal working plant, and was discovered by an employee in a room containing 21 open-topped 50-gallon drums of scrap metal including magnesium and aluminum. Sparks from an oxy-acetylene welding torch used to repair a machine dropped into one of the 21 drums containing miscellaneous metal, presumably magnesium and aluminum. Twenty sprinklers operated, holding fire in check. Upon arrival, the fire department used three public hose streams to extinguish the fire. Damage was slight.

Mar. 17, 1943, Aberdeen, Wash. Magnesium Powder Plant.
Magnesium powder manufacturing building consisting of groups of 1-, 3- and 4-story frame buildings without sprinkler protection were destroyed by fire believed to have been caused by static electricity in a dryer. A vacuum dryer had been in operation during the day, drying ground magnesium. The powder was dried in cotton bags on enameled trays. The bags of powder were being removed by the night shift and emptied by hand into metal containers which were then sealed. This work was carried on adjacent to the dryer. The empty cotton bags were piled on a wooden bench. The pile of bags burst into flames and fire spread very rapidly, as the various hazardous areas were not segregated. Two fire department pumpers supplied four hose streams and the detached warehouse and office buildings were saved, but all manufacturing areas were lost. Loss: $81,000.

Apr. 19, 1943, Los Angeles, Calif. Metal Worker.
Fire damaged a one-story, ironclad and joisted roof metal working plant comprising a single fire area when magnesium alloy castings for airplane parts were placed in a bath of molten sodium nitrate intended for aluminum alloy castings. Resulting explosion carried blaze to the roof, scattering flaming fragments of magnesium alloy throughout the building. Fire department fought the blaze with 12 hose streams, but fire extended throughout entire plant area and the tremendous heat warped machinery, including delicate heat recorders. Loss: $8000.

May 3, 1943, Las Vegas, Nevada. Magnesium Refinery.
A temporary refinery building of one-story concrete construction with wood-joisted roof at a magnesium plant was destroyed by fire when a leak occurred in a magnesium crucible while in refinery furnace, allowing molten magnesium to flow through furnace flue, igniting wall material adjoining flue. After start of fire, accumulation of sulphur dust previously used to control magnesium fires flashed and fire quickly involved the temporary building. The fire also damaged the adjoining electrolysis building by burning asphalt protection from the corrugated roofing. Four hose streams were used to extinguish fire. Small spot magnesium fires were controlled by manually applied flux. Loss: $33,857.

May 29, 1943, Elkton, Md. Magnesium Plant.
Lightning struck a magnesium plant, causing fire which destroyed the building. No further data available.

July 26, 1943, Cambridge, Mass. Foundry (Magnesium and Aluminum).
One thousand pounds of castings in an electrically heated metal air circulating oven ignited. The cause was probably due to castings containing some thin projection or fine dust particles which are subject to ignition at lower than normal temperatures. The oven was thermostatically controlled and excessive heat was not a factor. The rough parts of castings had been previously removed by a machine saw and it is possible that some particle was left on castings. A fog stream was applied by firemen and after some 35 minutes fire burned out. Special extinguishing powder was used by employees. The use of water simply acted as an accelerator. It has been recommended that the oven be made air tight and that future heat-treating be carried out in a sulphur dioxide atmosphere to raise the ignition temperature of the magnesium. Loss: $2866.

July 31, 1943, Los Angeles, Calif. Airplane Parts.

Fire occurred in unsprinklered magnesium foundry when a workman moving a pot of molten magnesium struck it with a mold, causing about six pounds of magnesium to spill and ignite. Fire was extinguished by applying special extinguishing powder, and fire was out upon arrival of fire department in response to a thermostatic alarm. Good housekeeping in foundry prevented spread of fire. Damage to building and contents was small.

Sept. 13, 1943, Malden, Mass. Magnesium Plant.

One employee lost his life as the result of an explosion in a one-story frame shed at a magnesium plant. It is believed that foreign material in magnesium in the hammer mill caused a spark, which traveled through a pipe to the collecting shed and ignited magnesium dust. The resultant explosion destroyed two collecting sheds and blew back through the pipe to the hammer mill, causing fatal burns to the mill operator. Another employee was severely burned, as was a sailor who attempted to rescue the mill operator. Two hose streams were used to extinguish fire. Special extinguishing powder was also used inside No. 1 mill. The explosion and resulting fire destroyed three plant buildings. Loss: $8800.

Dec. 15, 1943, Dallas County, Texas. Magnesium Plant.

Fire occurred in the foundry section of a one-story steel frame, metal-clad plant. The foundry section was separated from the warehouse and adjoining areas by wood partitions extending to the eaves and without any protection for door openings. A wooden ventilating duct was ignited by sparks or hot gases. Embers fell into magnesium shavings from machines and fire spread to finished parts. Flames subsequently spread to the warehouse section containing 17 carloads of magnesium ingots. Explosions occurred as water from hose streams came in contact with burning magnesium. An adjoining plant building 20 ft. distant partly collapsed from the violence of these explosions. Loss $650,000. (See N.F.P.A. QUARTERLY, Jan., 1944, p. 255.)

International.

Well-publicized characteristics of magnesium incendiary bombs had apparently been ignored in designing this Dallas, Tex., plant, which burned on December 15, 1943.

Dec. 16, 1943, Dearborn, Mich. Aircraft Factory.

Fire broke out after 2 A.M. in a wooden box car filled with magnesium chips. It had been planned originally to ship this magnesium in metal containers, but permission was granted to make shipment of magnesium scrap loose in box cars. Employees were loading a car inside the packing and shipping area due to severe cold weather. The source of ignition is not known. Employees removed the burning box car to a safe distance and allowed the magnesium to burn itself out. The fire continued until the following day. There was considerable structural damage as well as interruption to production. The initial loss estimate was $925,000, but was subsequently adjusted at a somewhat lesser amount.

Dec. 30, 1943, Chicago, Ill. Magnesium Foundry.

Fire due to arcing at an electric light fixture spread to magnesium castings. The fire department was not called for ten minutes, during which time a severe flash fire occurred, fusing 31 automatic sprinklers. The fire department did an outstanding job in controlling this fire. No water was applied (other than from the sprinklers) until the area was ventilated through the roof and seven hose streams were in readiness. Thereupon, the burning magnesium was subjected to a deluge. The first reaction was a darkening of the fire almost to the point of extinguishment. This was followed by a flash and a mild explosion which was repeated several times. Sprinklers continued to operate and checked a small blaze which started in an adjacent room. Damage was confined to an area approximately 10 by 12 feet, containing 6500 pounds of magnesium castings, which were consumed. About 75 per cent of the castings in the room were undamaged. Total loss placed at $18,000.

Jan. 4, 1944, New York, N. Y. Foundry and Machine Shop.

Fire occurred on the first floor of this one- and two-story brick-joisted plant engaged in cleaning and grinding bronze, aluminum and magnesium castings. An explosion of magnesium dust cost the life of one employee and badly injured several others. The explosion probably was caused by a portable electric cleaning grinder coming in contact with foreign material. It occurred at a metal enclosed booth. The ensuing fire was extinguished by chemical extinguishers. Moderate property loss.

Mar. 24, 1944, Cambridge, Mass. Magnesium Foundry.

Fire occurred in room used for snagging and grinding magnesium castings. Hood over grinding stone was wedged with corrugated cardboard and wood to stop the vibration. The cardboard contained magnesium dust, and oil rubbed against the side of the grinding stone until friction heat ignited and set fire to oil in reservoir and duct system. Seven sprinklers operated, holding fire in check until fire department arrived. A 2½-inch fog applicator was used to extinguish the fire. Employees used several pails of special extinguishing powder. The damage was mostly to the metal ducts and air filtering unit. Loss: $3500.

Fire-safety recommendations were not heeded in this magnesium foundry, which burned on March 24, 1944.

Mar. 24, 1944, Los Angeles County, Calif. Magnesium Casting Plant.

Fire followed an explosion in the exhaust vent of one of the grinders in this magnesium plant. The grinders were not separated from the rest of the foundry area. Fire spread over approximately 13,600 sq. ft. of area, spreading rapidly on ledges and walls, where magnesium dust had accumulated. Recommendations by the military fire protection authorities for isolation of the grinding operations had not been complied with, despite previous fire. The fire department used several hose streams to prevent further spread of the fire. Loss approximately $65,000.

May 1, 1944, Syracuse, N. Y. Metal Worker.

Sparks from steel stock being turned on lathe ignited magnesium turnings which had not been cleaned from pan underneath machine following previous magnesium machining operations. Three sprinklers opened, holding fire in check. The damage to building and contents was slight.

May 22, 1944, Hamtramck, Mich. Magnesium Storage.

Fire, possibly due to lightning, involved an outdoor storage area consisting of 3000 metal drums containing over 267 tons of magnesium chips being delivered to a magnesium refinery. The intense heat ignited four more buildings, chiefly dwellings. The fire department devoted its efforts to protecting these exposed properties, which suffered $6820 damage. Loss to the magnesium storage is not given.

May 23, 1944, Cambridge, Mass. Magnesium Foundry.

Magnesium dust was ignited by a spark from an electrically operated hand tool used to clean and face a grinding stone. Fire spread to oil in the reservoir of oil filtering system and duct system, but was held in check by one sprinkler until fire department arrived. A 2½-inch fog applicator was used to extinguish the fire. Damage was slight.

June 29, 1944, Burlington, Vt. Metal Worker.

One employee was badly burned in a fire at a factory manufacturing gun mounts for the Army and Navy. Apparently, sand in a magnesium casting caused the overheating of cutting tools, igniting chips. Two sprinklers held fire in check until employees were able to extinguish the fire with special extinguishing powder and carbon dioxide extinguishers.

July 27, 1944, Cleveland, Ohio. Magnesium Plant.

Fire, believed due to a poorly installed smokepipe for a water heater, destroyed one-third of the main building of this government owned magnesium smelter plant. Flames also spread to an annex office structure, as well as to near-by box cars. The main plant building was 1 equals 4 stories in height with concrete and earth floors, and roof of gypsum slabs on a steel frame. This large loss was attributed to careless housekeeping. Burlap bags filled with magnesium scraps were piled to a height of 10 feet in close proximity to the heater pipe.

Aisle space was also insufficient. When fire was discovered, employees' attempts to use a special extinguishing powder applicator unit proved unsuccessful when electric power to this unit was interrupted by the fire. Upon failure of this effort, employees resorted to a hose stream from a yard hydrant. Eventually, an alarm was given to the public fire department over a telephone, although there was a fire alarm box within 50 ft. of the fire. The area in which the fire started was without automatic sprinkler protection, although sprinklers in exposed sections operated with limited effect due to the advanced state of the fire and heavy damage upon the water supplies. Loss: upward of $250,000. (See N.F.P.A. QUARTERLY, October 1944, p. 127.)

Aug. 5, 1944, Baltimore, Md. Magnesium Foundry.

Fire occurred in the early morning hours in a heat treating oven on first floor of a one-story brick and concrete building. The ovens are specially designed for this purpose and are sealed while in operation, but are equipped with an audible signal to give an alarm when temperature exceeds 800° F. An employee in charge heard the alarm and notified the fire brigade before opening the oven and attempting to extinguish the fire with one 650-pound special extinguishing powder machine. This powder is usually very effective, but some delay may have occurred, as all castings in the oven were partly or fully consumed and metal racks were also badly damaged. The exact cause of the fire is unknown, but it is believed to have been loose chips inside the castings or oven failure. In the future all castings are to be heat treated before chipping and machining to prevent possible fire from this source. Each oven is to be equipped with a helium smothering line in an effort to extinguish any fire before opening oven. Loss to oven and contents estimated at $6500.

Aug. 19, 1944, Philadelphia, Pa. Iron Works.

Starting in the storage yard of the block-long plant in some rubbish and empty crates, fire quickly involved a 20-foot stack of crates containing magnesium. This plant is engaged in government work, and data as to the exact cause of the fire have not been made available. Raw material and finished products reportedly were stored in an open yard without proper segregation or fire protection. Many near-by windows were broken by explosions. The fire spread to the plant and broke through to the roof. The fire department responded to fire alarms and used numerous hose streams to protect exposed buildings while allowing the fire to burn itself out. Forty-two employees and firemen were injured. No figures are available as to the amount of the loss.

Magnesium scrap in burlap bags piled close to a steam pipe started this war plant fire in Cleveland, O., July 27, 1944.

Oct. 21, 1944, Hartford, Conn. Machine Shop.

Fire started at a lathe. It is presumed that a dull cutting tool or a flaw in the casting ignited chips in the lathe bed and large (empty) oil sump basin. This fire spread so rapidly to another floor and to chips from another near-by lathe that operator did not have time to use the special extinguishing powder which was provided. Twenty-six sprinklers opened, which entirely extinguished fire except for minor use of a chemical line used by fire department on fire under benches. The damage was very moderate, involving lathe, which was restored to operation the same day.

Dec. 27, 1944, North Bergen, N. J. Metal Worker.

Fire started on the first floor of a one-story brick building, where airplane engine parts were being made. An employee was getting ready to pour 90 pounds of molten magnesium. He set the round bottom pot on the floor and allowed it to tip over. The molten magnesium spilled and ignited 150 feet of rubber air hose and a wooden pattern. One sprinkler opened, holding the fire in check. Loss: $1200.

Acme.

Eight men were killed and nine injured in this fire at Wright Field, Dayton, Ohio, on March 5, 1945. Burning magnesium complicated the fire-fighting problem.

March 5, 1945, Wright Field, Dayton, Ohio.

An explosion occurred when a Lockheed C-60 taking off from Wright Field crashed into the doors of a modification hangar. Octane gasoline ignited, and fire spread rapidly through the hangar, in which there were no automatic sprinklers. Difficulty in extinguishing magnesium metals caused reignition of pools of gasoline about the floor of the hangar and complicated the fire-fighting problem. Eight men were killed and nine injured. Total losses reached $3,000,000, but even more important than the money loss was the destruction of important experimental aircraft.

Mar. 8, 1945, Leaside, Ont. Magnesium Plant.

Fire, believed due to breaking of an oil line near melting pots, ignited a pile of magnesium. Building was well ventilated, and the fire department used special extinguishing powder, applied with shovels, to cover piles of burning magnesium. One hose stream was used to protect a platform near the building. Loss was limited to $5000.

Mar. 12, 1945, Portland, Me. Machine Shop.

This plant was making airplane and automobile engine parts. A spark ignited magnesium and aluminum dust in dust removal system piping in a machine shop making airplane engines. One sprinkler opened, holding the fire in check until it could be extinguished. Damage was slight.

May 4, 1945, Boston (Hyde Park), Mass. Magnesium Foundry.

The fire occurred in a one-story foundry and machine shop. Fire started in section containing hydraulic dye casting machines where zinc castings were being made. Rupture of a 275-gal. oil tank spread fire to another section where magnesium castings were being made. Fire department avoided use of hose lines near heated magnesium at request of plant employees. Considerable damage to both of sections involved. Loss: $35,000.

Loss of Life by Fire.

By Robert S. Moulton,
Chairman, N.F.P.A. Committee on Fire Record.
Secretary, Committee on Safety to Life.

Fire takes an annual toll of some 10,000 lives in the United States alone, according to the estimates of the National Fire Protection Association. Loss of life by fire may be statistically insignificant when compared with war casualties, but there is something so terrible about death by fire and such deaths are so unnecessary that there is great popular interest in loss of life by fire, and fires causing any extensive loss of life always receive widespread newspaper publicity.

The annual loss of life by fire in the United States for a considerable period of years has averaged around 10,000, according to N.F.P.A. estimates. It is indeed distressing that fire deaths should continue at this high level in spite of constant improvements in building construction, more widespread installation of automatic sprinklers, and more efficient fire department operation. These factors have all had their effect in improving life safety from fire, but there have been other offsetting factors, particularly the progressive increase in the smoking habit, which have multiplied by many fold the potential sources of ignition. Smoking has now become so universal that carelessly discarded matches and smoking materials are the No. 1 fire cause in practically every class of property, including many types of properties where smoking was strictly "taboo" a few decades ago.

U. S. Census Figures.

In our opinion the U. S. Census mortality statistics, while giving a relative indication of the loss of life by fire as classified under the Census headings "Conflagrations" and "Burns," fail to give a true picture of the situation because they do not include many types of indirect fire casualties which the N.F.P.A. feels should be considered as fire deaths. For example, we consider as fire casualties deaths due to drowning when forced overboard from a fire at sea, accidents to firemen sustained at fires or in responding to fires and deaths from diseases such as pneumonia contracted as a result of fire exposure, which may not occur until long after the date of the fire and which may not include any mention of fire on the death certificate. The U. S. Census statistics of loss of life by fire run around 7000 to 8000 annually.

The N.F.P.A. tabulation on page 49 shows the causes of loss of life in fires in which 18,592 lives were lost during a 15-year period. This includes only fires reported to the National Fire Protection Association's Department of Fire Record, and is a typical sample representing a little over 10 per cent of the estimated total casualties. The volume of data, however, is sufficient to draw conclusions as to the relative importance of the various causes of loss of life. The table on page 48 shows loss of life classified by occupancies.

The table showing causes of loss of life by fire has been prepared to show the actual cause of loss of life, which is not necessarily the same as the cause of the fire. In many fires the cause of the loss of life is not immediately related to the original cause of the fire; in the case of people trapped in a burning building the result would be the same irrespective of whether the fire started from careless smoking, from a defective heater, or from spontaneous ignition of oily rags.

The classification "Trapped in Burning Buildings," with 5311 fatalities recorded, represents nearly 30 per cent of the total, and is the most important single cause of loss of life by fire. This includes a wide variety of fatal fires, ranging all the way

from the typical small dwelling in which a fire starts in the basement or kitchen while the family is asleep on the second floor and the flames cut off the only stairway before they can make their escape, to the Cocoanut Grove Night Club fire, where 492 lives were lost due to inadequate or locked exits. If the original cause of fire can be eliminated, no fire will occur, but owing to the ever present possibility of failure of the human element, or of mechanical equipment, reasonable life safety calls for some adequate means of escape in case fire does occur despite precautions.

A closely related cause of fatalities is asphyxiation, with a total of 802 deaths recorded. These fatalities may in some instances have been due to persons being trapped, but more commonly include the cases where persons have been asleep or have unknowingly breathed in quantities of dangerous gases. Another related cause is presented in the 186 fatalities listed as "Escaping Fire, Jumped, Fell or Drowned." In most cases the victims of these fires presumably thought that they faced certain death in a burning building, and jumped rather than remaining to be burned to death. However, in a good many instances the victims succumbed to panic, rather than fire, and might have been rescued by firemen if they had waited a few minutes longer. Panic is a factor in many other classes of fire fatalities. Experience shows that in the presence of fire or smoke, particularly where there is a crowd, the ordinarily normal individual is all too likely to behave irrationally, and this factor must always be considered in designing exits or in any planning for fire emergencies.

Fire Fighting.

Fire fighting is listed as the cause of 471 deaths. Some of these fatalities were due to errors in judgment on the part of amateur fire fighters who remained too long in a burning building. Deliberate exposure to personal danger in a burning building is justified only for the purpose of rescuing others. This is a hazard which firemen are commonly exposed to as a part of their regular duty, and many of the fatalities listed under fire fighting occurred as the result of attempts by firemen to rescue fire victims. The 196 deaths due to entering burning buildings are largely cases where persons escape from a burning structure, and then return to recover jewelry or clothing, not realizing the danger of heat and gases from rapidly spreading fires.

Flammable Liquids and Gases.

Flammable liquids and vapors have been responsible for 2466 fatalities as shown by the table, or about 13 per cent. These fires include a wide variety of liquids that are used for various purposes. In practically every instance it can be shown that the deaths have been directly or indirectly due to lack of ordinary care in the use of flammable liquids. Gasoline and similar fluids used for home dry cleaning purposes in violation of every sort of published warning, the use of gasoline or kerosene to kindle fires in kitchen stoves, and lack of proper care and maintenance in filling oil stoves and lamps are responsible by far for the greater proportion of these fatalities. It is interesting to note that oil-fired furnaces are listed as responsible for only 24 of the 2466 deaths. This may be explained by the fact that oil furnaces commonly used are of a standard, well-safeguarded type installed by men specializing in this type of work, whereas gasoline and oil stoves, often of improper design, are purchased and installed by the householder with no expert supervision. Paints, varnish removers and thinners, while potentially hazardous and commonly bearing a warning that they should not be used in the presence of open fire or flame, have been responsible for only 27 deaths. This may be explained by the fact that as paints and varnishes are commonly used, only relatively small quantities are applied at one time, so that unless there is poor air circulation there should be no dangerous concentration of flammable vapors. The cases where fatal fires have occurred from such causes are for the most part instances

of obviously improper use of such products; for example, heating a can of paint on a stove to make its contents flow more freely.

Fatalities peculiar to children are separately listed under the headings "Children Alone in House" and "Children Playing with Matches." According to this record, 473 lives have been lost in cases where small children left alone in the house without parental supervision have started a fire in one way or another. For the most part these fires have presumably been started by the children, although after the fire there has been no evidence to suggest what the children did. In the 254 cases reported as children playing with matches, there is definite knowledge that the fire started in this way. These two classifications together represent a total of 727 deaths, or about 4 per cent of the total. Many of the other classifications in the table also include fatalities to children from causes that involve both children and adults.

Ignition of Clothing.

Fourteen hundred and forty fatalities, or nearly 8 per cent of the total, are listed under the heading of "Burns," including cases where clothing or bed clothing ignited because of various causes. The 293 deaths recorded where persons fell asleep smoking; the 470 lives lost where persons exposed themselves to sparks and flames from furnaces, stoves, and heaters; and the 202 lives lost due to bonfires and burning rubbish all represent cases of obvious carelessness where lives might have been saved through the exercise of reasonable prudence. In many of these cases the fatalities would have been the same irrespective of the clothing worn, but it is obvious that light flimsy clothing is more easily ignited than heavy garments, and that cotton burns more readily than wool. Wearing easily ignited garments in the vicinity of fire is an invitation to fatal burns. Recently there has been considerable publicity given to the fatal burns sustained by the wearers of garments made of very flammable textiles, reported to have been made of synthetic fibers. While it is true that a number of persons have been burned to death by the ignition of garments having a high degree of combustibility that was unsuspected by the wearer, to date there is nothing in the record to indicate that there has been any material increase in fatal fires in this class since the advent of such combustible textiles, as compared with previously used combustible fabrics such as cotton. Primary emphasis should be placed on the avoidance of ignition of clothing of any type.

Explosions.

Explosions of various types accounted for 1889 deaths, or approximately 10 per cent of the total. There is no sharp dividing line between a fire and an explosion. The rate of burning of flammable gases or vapors determines whether the occurrence is a fire or an explosion. Where the gases or vapors are mixed with air in certain proportions before ignition occurs, the result is an explosion. From the point of view of loss of life by fire, the essential difference is that in the case of fire only those in the immediate vicinity are killed, whereas with an explosion the fatalities may extend over a considerable area and involve those some distance away. In the case of either fires or explosions from flammable liquids or gases the precautionary measures are the same, including such details as the ordinary care in the handling of the materials, proper ventilation to carry away explosive fumes, avoidance of potential sources of ignition in the vicinity, and other recognized precautions.

A considerable number of fires in this record have been classified under the following general occupancy classes: "Aircraft Fires," "Forest and Brush Fires," "Marine Fires," "Mine Fires," "Motor Vehicle Fires," and "Railroad Fires." In these cases the fire fatalities are associated with the general class of occupancy, and in most instances, it is impossible to determine the immediate cause of death except that it has been due to fire. Characteristics of such fires are those reported under aircraft. The great majority of such fatal fires

occur in connection with crashes or other accidents to aircraft where gasoline is released and ignited, burning occupants to death before they have an opportunity to escape. This situation is complicated by the fact that in many cases the occupants are either trapped or are injured so that they are unable to extricate themselves properly without assistance. In this and the other occupancy classifications, only those deaths have been included where it appears clear that the death was directly due to fire. In crashed aircraft where the occupants of the planes have been killed by the impact before fire occurs, the fatalities have not been classified as due to fire.

Space does not permit detailed explanations of the various other classifications of fatalities listed. However, it can be clearly shown that the deaths from fire are wholly unnecessary and could readily be prevented by the exercise of reasonable care in the control of fire hazards, by provisions for the prompt detection of fire, and escape from burning buildings, and other elementary precautions which could be observed without undue difficulty or inconvenience if everyone would keep the danger of fire constantly in mind and never forget to take reasonable precautions for personal safety.

Loss of Life by Fire — Class of Fire.

A record, 1930-1945, of fires reported to the National Fire Protection Association, representing about a 10% typical sample of total estimated fire fatalities.

Occupancy	No. Fires	Men	Women	Children	No Data	Total
Aircraft	294	596	69	15	181	861
Airports and hangars	13	14	3	0	0	17
Apartments, hotels, lodgings, tenements, etc.	940	988	526	362	11	1887
Barns and stables	79	52	5	47	0	104
Boats and ships (except tank vessels)	131	292	78	21	0	391
Tank vessels	40	227	2	0	0	229
Buildings under construction	9	20	0	0	0	20
Churches and church property	25	19	10	6	0	35
Conflagrations	24	40	12	12	0	64
Dwellings—rural	2109	883	889	2145	0	3917
Dwellings—urban	2230	831	1071	1180	0	3082
Dwellings—trailers	30	10	13	29	0	52
Forest and brush fires	91	162	9	19	0	190
Garages and filling stations	121	150	8	7	0	165
Gas works	13	151	19	5	3	178
Grain elevators	22	69	1	0	0	70
Hospitals and institutions	105	204	118	32	0	354
Manufacturing occupancies	462	953	99	13	19	1084
Mercantile occupancies	160	198	27	12	0	237
Mining property	130	1401	0	0	0	1401
Motor vehicles (except tank trucks)	457	626	197	95	0	918
Tank trucks	71	126	15	3	0	144
Oil and gas wells	28	73	3	3	0	79
Oil refineries and bulk distributing plants	79	169	9	2	0	180
Out of door fires	410	196	42	219	0	457
Railroad rolling stock	50	109	0	3	21	133
Response to alarms	134	165	5	7	0	177
Restaurants	38	319	257	2	202	780
Schools and colleges	31	43	20	332	0	395
Theatres	16	20	1	1	0	22
Other known buildings	339	510	170	138	7	825
No data	78	82	36	26	0	144
Total	8759	9698	3714	4736	444	18,592

Causes of Loss of Life by Fire.

A record, 1930-1945, of fires reported to the National Fire Protection Association, representing about a 10% typical sample of total estimated fire fatalities.

Cause of Loss of Life		Number of Deaths
Aircraft fires		861
Asphyxiation (smoke and gas suffocation)		802
Burns (clothing or bed clothing ignited from):		
1. Bonfires, burning rubbish, etc.	202	
2. Candles and torches	31	
3. Electrical appliances	66	
4. Fireplaces and open grates	78	
5. Furnaces, stoves, and heaters	470	
6. Smoking and matches	144	
7. Fell asleep smoking (in bed or on couches, etc.)	293	
8. Miscellaneous	156	
		1440
Children alone in house		473
Children playing with matches		254
Entering a burning building		196
Escaping fire: jumped, fell or drowned		186
Explosions:		
1. Acetylene	16	
2. Chemicals	43	
3. Dusts	114	
4. Electrical transformers and switches	17	
5. "Empty" tanks, welding of	22	
6. Explosives	146	
7. Fireworks	92	
8. Liquefied petroleum gases	41	
9. Manufactured and natural gases	812	
10. Miscellaneous and unknown	586	
		1889
Fire fighting		471
Flammable liquids and vapors		
1. Alcohol	55	
2. Gasoline and similar liquids		
(a) Stoves, lamps, and torches	153	
(b) Used for cleaning purposes	267	
(c) Used to kindle fire	169	
(d) Miscellaneous	345	
3. Kerosene, range oil, and fuel oil		
(a) Stoves, lamps, and torches	393	
(b) Used to kindle fire	599	
(c) Oil furnaces	24	
4. Paint, varnish removers, thinners, etc.	27	
5. Petroleum production and storage	157	
6. Miscellaneous and unknown	277	
		2466
Forest and brush fires (including fire fighting)		197
Indirect causes (overexertion, exposures, etc.)		146
Marine fires		541
Mine fires and explosions		1362
Motor vehicle fires (except tank trucks)	918	
1. Tank trucks	144	
		1062
Nitrocellulose materials		61
Railroad rolling stock fires		133
Response to alarms		179
Trapped in burning building		5311
Miscellaneous known causes		76
No data		486
Total		18,592

Fire Prevention in Retail Stores.

By Harry L. Shearer, Asst. Secretary,
Detroit, Mich., Board of Commerce.
(Member N.F.P.A.).

Fire prevention in retail stores covers a vast field. For years we have concentrated attention on fire prevention in industry, motion pictures, hospitals, theatres and night clubs, but never on the problem of the retail store, although it is the second largest occupancy classification. The hazards of retail stores are more readily discernible than those in industry, yet industry has a better fire record. In Detroit alone last year, there were nearly one thousand fires in the mercantile classification.

Some retail store organizations, however, have instituted fire prevention programs and two nationally known chain stores operating in Detroit have had excellent results from their programs. One organization with hundreds of stores throughout the country reports:

"We have always believed there should be more activity in fire prevention in the retail field. Although we have no official figures, the buildings of all types must make up a large percentage of structures in the country. The employees involved and the people served must certainly add up to a staggering figure. In addition to this, retail merchants are entrusted with a tremendous amount of the country's resources.

"We unfortunately experienced several disastrous super-market fires shortly after this country entered the present war. It is particularly important that we in the food business do everything possible to protect and conserve food which is so vitally important to the war effort. For this reason we inaugurated a fire prevention program, and recently this program has branched into an overall program of fire prevention, safety and sanitation, all of which we feel go hand-in-hand. A Fire Warden, who was given jurisdiction over 166 retail outlets, 8 buildings, housing offices and warehouses, was selected to organize such a program. His duties consisted of educating the personnel of each operation to the fire hazards encountered in his particular line of work and the action necessary to eliminate these hazards. He also studied the various types of fire fighting equipment necessary to the safe operation of the buildings in order to intelligently recommend their purchase when required.

"Education of the employees in fire prevention was accomplished mainly through the following:

1. A monthly fire prevention bulletin directed to the store manager, pointing out the hazards to be found in his particular type of market and suggesting ways to eliminate them.
2. Promotion of seasonal inspections by the store personnel.
3. Posters — some of which were produced by our organization and others which were nationally circulated.
4. Literature supplied by the Detroit Fire Department.
5. Using a part of each quarterly sales meeting for the purpose of impressing upon the various managers the seriousness of fire and the importance of preventing it.
6. Creating widespread interest in the different warehouses through a monthly inspection pertaining to fire prevention, safety, sanitation and cleanliness. This inspection is made by a committee consisting of the operating superintendent, fire warden, chief engineer and three employee-members, chosen at random each month.

"One of the first functions of the program was to become a member of the National Fire Protection Association. This keeps us currently posted on the happenings within the field of fire prevention. Later our fire warden, accompanied by a Detroit Fire Department inspector, visited all our retail outlets in order to become thoroughly familiar with the methods and details of the work. The cooperation of the Fire Prevention Bureau of the Detroit Fire Department has been responsible for a great deal of our success and without it we would have been greatly handicapped.

"From the regular routine inspections covering fire and safety hazards, a report of the necessary mechanical and construction work is relayed to our Maintenance Department and any laxity in management involving these items is reported to the authorities in charge.

"As an outgrowth of the fire prevention program a housekeeping department was recently introduced which will operate in the interests of fire prevention, safety, sanitation and cleanliness. As each of these items depends to a degree upon each other, this department should increase the effectiveness of our fire prevention activities and our future should bring many new developments in this field."

This company has found one particular cause of fires during its campaign. During the day store floors become covered with debris of many kinds, much of it flammable. At the close of the day one manager had been sweeping all this debris into one pile at the back of the store, where much of his produce was stored, and leaving it until morning. It was found that shoppers had been dropping lighted cigars and cigarettes on the floor and some of these were swept into the back room with the rest of the debris. The resulting fire caused a loss. This procedure has now stopped and metal containers have been provided for every store. These containers are placed outside the store when the manager leaves at night, with the result that since that time there has been no loss from this cause.

Since the inception of this program this company has had a representative on the Detroit Board of Commerce Fire Prevention Committee and takes an active part in helping the entire city fight the fire problem.

Another large organization has recognized the benefits of the fire prevention campaign for a good many years. Their campaign has saved money and kept their stores in business. In 1938 there were 153 major fires, with losses in each case of more than $10,000, and 51 minor fires, with losses under $10,000. In 1941, after inaugurating their fire prevention program, they had no major loss fires and their minor losses totaled only $10,000. In 1943 they had just one major loss of $60,000 and their minor losses were $12,000. This is an excellent record, considering that this company maintains nearly 800 stores scattered throughout the United States and Canada.

This organization sends monthly orders from the main office to each manager. With these orders is included a nicely printed inspection blank with detailed inspection instructions. Each store is graded on its inspection and every store manager who is lax in carrying out his orders is penalized.

These orders include: No smoking in any part of the store, including the delivery department; keeping the boiler room free from fire hazards; removing ashes and sweeping from the building, or keeping them in covered metal cans in the boiler room — not in the baling room; keeping baling room clean, with the door closed and in good condition; depositing combustible materials, oily rags, etc., in metal containers; removing all oily rags, waste paper, etc., from beneath checking tables; keeping checking drawers clean and orderly; storing combustible merchandise a safe distance from stoves, hot plates, or fuses; checking electrical equipment on windows, counters and in stockrooms for loose connections, seeing that it is properly installed and disconnected at night; keeping ducts cleaned and free of grease.

When a store manager receives a penalty notice which reads "In the future we shall expect to receive a report from each store regularly," he immediately gets busy, for inspection is one very important phase of the work that can ill afford to be neglected. Each of these special colored bulletins carries an order and a message. Sometimes they cover in detail the various phases of the orders; Christmas holidays, Fire Prevention Week, Clean-up and Paint-up Week are covered. When a fire occurs in any of the stores a complete analysis of the cause is sent to every store manager. After a bad fire had occurred through the incorrect use of spotlights in windows, a bulletin was sent out on their use. Hardly a week goes by that the store managers do not have hazards called to their attention, for it has been found that this pays dividends.

Any retail executive, no matter what the present condition of his property, can go a long way towards fire safety through more or less standard good practice procedures such as illustrated above. If these standard precautions were regularly taken by retail merchants, the retail fire loss in the United States would undoubtedly show a sharp decline.

NOTE: This article is from the address given by Mr. Shearer before the National Fire Waste Council in Washington, D. C., April 13, 1945.

British Studies of Burns and Scalds.

The avoidance of infection should dominate first aid policy for all but very severe burns. Burned patients should be treated in centers specially staffed for the purpose. These are two primary lessons of a recent series of British medical papers.[1] The application of these two lessons is as much in the hands of laymen as of the medical profession. There are many large industries, for example, where proper first aid procedures can be rigidly enforced, and some which can maintain centers operating under the high standards of practice required to prevent the loss of patients due to infection and other complications which may develop under ordinary hospital conditions.[2]

The following extracts from these reports are for the most part verbatim and are published here by permission.

In the four years immediately preceding the war there were approximately 1270 deaths per annum from burns and scalds in England and Wales, of which nearly half were at ages under 15. The many thousands of burned patients who did not die represent a formidable loss of manpower in industry and of school-hours. Many recovered with crippling deformities.

In the present war, in which petrol engines, explosives and fire play so large a part, burns and scalds have become still more important, and their treatment one of the major problems of war surgery. At El Alamein, one in four of the battle casualties were of this nature, and all through the desert campaign, quite apart from actual fighting, serious accidental burns due to petrol were of common occurrence.

These injuries present many unsolved problems. It is not clear why damage to the skin — sometimes, in children, involving only a tenth of the body surface — should so often prove fatal. Nor has it been possible up till now to prevent septic infection of most of the deep burns — as well as many of the more superficial ones. Skin replacement by grafting procedures has greatly assisted healing, but the possibility of improved methods needs to be explored. Finally, there is a whole train of difficult metabolic problems created by the long continued suppuration and exudation from the burned surfaces, and by the destruction of tissues.

The need for investigation of all these questions has long been recognized — indeed many inquiries have been set on foot in years gone by — but progress has been slow. It has always been hampered by the fact that burns and scalds occur at irregular intervals and the patients are received into every general hospital. Nowhere in Britain had there hitherto been a concentration of patients together with a team of surgeons and laboratory workers with facilities for a prolonged systematic study.

At the Royal Infirmary, Glasgow, wards have for many years been set aside for the treatment of burns, and a larger number of these injuries is dealt with there than at any other hospital in the British Isles (about 1000 fresh cases every year).

The present report embodies observations made in 1942 and 1943 on some 400 in-patients with burns, and on nearly 2000 patients with less severe burns who were treated as out-patients.

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[1] "Studies of Burns and Scalds," Medical Research Council Special Report Series No. 249. His Majesty's Stationery Office, 1944. 210 pp. 4s. 0d. net. Available in the United States from British Information Services, 60 Rockefeller Plaza, New York, N. Y. $1.20.

[2] See also "Treatment of Burns with Aniline Dyes," Aldrich, N.F.P.A. QUARTERLY, April, 1939, p. 366; and "Treatment of Burns," Lund, N.F.P.A. QUARTERLY, October, 1943, p. 111.

Part I. The First-Aid Treatment of Burns and Scalds.

There is no agreed policy with regard to the initial treatment of burns. Owing to the natural urge on the part of the patient or his friends to do something (however ill-advised), it has been found that about 75 per cent of civilian patients arrive at hospital with some kind of application to the burned area — olive oil, carron oil, flour, coagulant jellies, cold tea, sodium bicarbonate, an "ointment" or flavine, etc. — often covered with a dirty, or at least a non-sterile, piece of cloth. Frequently, pain has not been relieved by these applications — sometimes it has been increased; and the difficulty of removal of the semi-coagulated jelly, of the oil or caked flour may well augment considerably the original trauma suffered by the burned tissues, thereby favoring the development of "shock." First-aid remedies of this kind, especially if applied as they usually are without aseptic precautions, may well do much more harm than good.

In view of the great importance of burns in the mechanized warfare of today, and their contribution to wastage in industry, we have attempted to formulate a simple first-aid procedure which would be generally applicable, and have a satisfactory scientific basis.

1. The avoidance of infection by hæmolytic streptococcus should dominate first-aid policy for all but very severe burns. In the latter, measures for the preservation of life will often have to take precedence over local treatment of the burns.

2. For most small burns which are accessible, *e.g.,* of the hand or forearm or head, first aid at the scene of the accident should usually be limited to covering the injured skin with a recently laundered clean towel, or, better, if it is available, with a sterile cloth. (Wherever burns are likely to occur, such cloths should be kept ready, previously sterilized in an oven and stored in a tin.) With the burn thus covered, the patient should be sent at once to the factory "surgery," or to a hospital or a private doctor.

In all severe or extensive burns, no first-aid should be attempted other than keeping the patient warm and giving morphine if required. Immediate removal to hospital is the first consideration.

3. When quite superficial small burns are treated at home or when, in the case of more severe burns, the plenary treatment cannot be carried out without considerable delay, it is recommended that the burned area and the skin around should be freely smeared with a water-soluble cream containing 1 per cent of cetyl trimethyl ammonium bromide and 3 per cent of sulphanilamide. This cream should be applied with a knife blade or spoon, previously sterilized by dipping for two minutes in boiling water. *The burn should not be washed before the cream is applied, nor should blisters be snipped.*

This first-aid treatment must be carried out with due precautions against the transfer of streptococci to the burned surface. Thus the operator's hands must be thoroughly washed and dried, and he should wear a gauze mask or a clean handkerchief over his mouth and nose.

After being smeared with the cream, the burn should be carefully wrapped in sterile lint and a bandage, or in a recently laundered clean towel.

On no account should blankets be allowed to come into direct contact with the burn because they are often heavily contaminated with pathogenic organisms.

4. The cream should not as a rule be left on the burn for more than two days, as there is a slight risk of its inducing a dermatitis if left longer.

In special cases — *e.g.,* in a small ship, or in shipwrecked persons — this small risk will be of no account in comparison with the much greater risk of infection if the burn is not treated.

5. The inclusion of a local analgesic in the first-aid cream is not recommended — for the following reasons:

(a) It is unlikely to give sufficient relief for the pain of a severe burn, which will usually require morphine.

(b) The pain of many small burns is so transient as to need no analgesic.

(c) Relief of pain by local analgesics is at best uncertain, and often short-lived.

(d) There is some risk of toxic effect from the use of local analgesics on a large burned area in susceptible individuals.

Part II. The Control of Infection in Burns and Scalds.

The coming of the sulphonamides, of penicillin and of propamidine has given us new power over the two micro-organisms — hæmolytic streptococcus and staphylococcus—which constitute the chief threat to the burned patient. These drugs, and the gradual awakening of surgeons during the last few years to the sinister influence of hospital infections, have created a new situation, and compel us to ask how far it is now possible to go towards attaining aseptic repair of the deep burn, with all its far-reaching benefits — quick healing with a minimum of pain, avoidance of contractures and keloid scars, as well as of many late deaths which formerly resulted from sepsis.

[This part discusses the bacteriology and epidemiology of burns and scalds. It reports that in only 21 of 282 cases was there acute septic infection. This impressed the authors as a low figure. They appeared concerned because 83 of the same 232 cases (30 per cent) admitted without hæmolytic streptococci, acquired them at some time during their stay in the hospital. A special drive against streptococcal infection was undertaken through special procedures which included strict techniques of dressings, elimination of dust, application of a bacteriostatic dressing, sterilization of blankets, bedpans and other items. Notwithstanding failure to keep burns free from streptococcal infection, the authors felt that the bacteriological effect hoped for has to a large extent been achieved by both sulphanilamide and sulphathiazole. They suggest the direction in which further progress may be made in the control of infections in burns. Ed.]

It appears to us axiomatic that the great majority of patients with burning injuries should, in future, be treated in centers specially staffed and equipped for the purpose — not scattered as heretofore in the ordinary surgical wards of hospitals, where their treatment has too often been entrusted to relatively inexperienced staff.

It is not proposed to discuss here in any detail the design, organization and equipment of such special burns centers, but we would suggest that the following features merit special consideration:

(1) An adequate surgical staff. The care of badly burned patients makes considerable demands on the surgeon's time and skill, both during the shock period and later. It should be the responsibility of a whole-time surgical officer, with more experience and authority than the average house-surgeon.

(2) Active and continuous collaboration in the control of infection, between the surgical staff and the nursing staff on one hand, and the bacteriologist on the other. Facilities for hæmatological and biochemical investigation will be required.

(3) A nursing staff sufficiently stable to permit of the maintenance of an exceptionally high standard of aseptic ward technique. There should also be a "pool" of nurses trained in the work of the center, from which additional help can be drawn in times of stress. The interest of all the nurses should be stimulated by some practical instruction in applied bacteriology.

(4) Provision for the dressing of all cases in an atmosphere free from dust and, so far as possible, from pathogenic bacteria. The most appropriate process of air conditioning for this purpose has still to be decided. Apart from filtration of dust particles, it will probably be necessary to employ some form of sterilization of the incoming air. This problem is at present being investigated.

The question of locating burns centers outside cities, if possible, so that the wards may be freely ventilated with clean air,

and the patients may get direct sunshine while their wounds are healing, will also need careful consideration.

(5) The exclusion of flies from the wards.

Part III. Replacement Therapy in Burns Shock.

The general reaction following severe burns — the so-called "Burns Shock" — still remains the most important single factor influencing the mortality in this type of injury. Analysis of the records of the Glasgow Royal Infirmary Burns Unit for the years 1937 to 1941 inclusive, reveals that, in a series of 1200 admissions, 49 per cent of the deaths occurred within 24 hours of the burn, and 72 per cent within three days. Only 4 of the patients received plasma or serum intravenously.

The sequence of physiological derangements which leads so often to death within the first three days of burning is still far from being fully understood. Pending more precise knowledge, it may conveniently be referred to by the comprehensive and somewhat vague term "burns shock." This condition is quite distinct in its clinical manifestations from the acute circulatory collapse of "primary shock," which may (but, in fact, seldom does) occur shortly after burning, just as it may after any other injury. The clinical features of "burns shock" as we have seen it will be described later in this report.

A number of different theories have been put forward in recent years to account for burns shock. Some workers, following Underhill and his colleagues (1923), have emphasized the loss of fluid from the circulating blood, with the resultant concentration of the cellular elements and a progressive anoxæmia of the tissues; others have invoked a variety of different toxic products thought to be derived from the burned tissues; others, again, have attributed the fatal issue to excessive sensory stimuli from the burned area. Deficient functioning of the adrenal apparatus has also been invoked as a possible cause.

In our study of burns shock in patients admitted to the Glasgow Royal Infirmary during 1942-43, we have concentrated attention chiefly upon the loss of fluid from the blood stream, upon the physiological changes associated with it and upon the effect of replacing the fluid lost, by transfusion.

Symptoms of burns shock in the majority of cases were much influenced by the administration of large amounts of fluid. In patients who received fluid only after evidence of shock was apparent, the symptoms observed were seldom those usually regarded as typical of surgical shock. In children, mental upset — characterized by drowsiness, restlessness, delirium and, rarely, convulsions—was the predominant feature.

[This part contains other clinical observations and a commentary on results which should be of interest to medical men handling burns cases, since it covers types of fluid used, the type of patient requiring replacement therapy, assessment of dosage, and management of the transfusions. It closes with the following summary. Ed.]

1. Observations relating to the duration of fluid loss after burns have been described. They suggest that 24-30 hours is the usual period. This is further corroborated by observations on hæmoconcentration. Replacement therapy, therefore, should be continued for at least 24 hours.

2. The results in a series of 62 patients treated with plasma or serum transfusions are detailed. These show that:

(a) Much larger amounts than hitherto recommended are often necessary.

(b) Dosage cannot satisfactorily be calculated by formulas, but should be assessed by repeated blood estimations while the transfusions are being given.

(c) Special attention should be directed to the control of replacement therapy in children.

(d) Adults with burns of over 15 per cent of the body surface, and children with

burns of over 5-10 per cent, require transfusions in amounts sufficient to replace the fluid lost and to prevent hæmoconcentration.

(e) In most cases, local treatment during the shock period should consist only of a first-aid dressing. Complete cleansing and dressing should be postponed until the second or third day.

(f) Almost complete control of burns shock may be obtained by adequate replacement therapy, begun as soon as possible after burning.

Part IV. Blood Changes and Blood Pressure in Burned Patients.

Although reference to changes in the erythrocyte (red blood corpuscle) count after burning injuries had been made on several occasions before the report of Underhill and his colleagues (1923), these authors were the first to stress the profound change in the red cell: plasma ratio (hæmoconcentration) which follows severe burns. They noted that this change appeared to vary with the severity of the burn, and that hæmoglobin values nearly twice the normal might be recorded in some instances. This concentration of the blood has been regarded as due either to loss of fluid from the circulation into the tissues around the injury (Underhill, 1930; Blalock, 1934), or to a more general and widespread permeability of the capillaries (Moon, 1942).

The development of anæmia in burned patients, at a somewhat later stage, has been the subject of much less discussion, though attention has been directed to hæmolysis (dissolution of red blood corpuscles) and hæmoglobinuria (hæmoglobin in the urine) in reports on the Cocoanut Grove disaster (Cope and Rhinelander, 1943).

Leucocytosis (excessive white corpuscles in the blood) is a common and early finding after burns. Locke (1902) recorded its occurrence within an hour of injury, and his findings support the view of Dorrance (1932) that leucocytosis of 50,000 p. c. mm. or over in the shock period is a very unfavorable sign.

[The principal findings of this part are given in a general summary and conclusions as follows. Ed.]

Part V. Chemical Changes in the Burned Patients.

The number of investigations reported in the literature of changes in chemical constituents in burned patients is not as large as might be expected, much of the work on the biochemical effects of burning having been done on experimental animals. Without going into a detailed description of the literature, for which the reviews, *e.g.*, those by Harkins (1941) and Rossiter (1943), may be consulted, one may say that there is general agreement that after burns in man a fall in plasma protein and chlorides and a rise in non-protein nitrogen may be observed. The evidence regarding other changes tends to be conflicting. In the present study it was considered necessary to investigate patients with burns of all degrees of severity, to determine the importance of any changes observed.

From the results obtained, some tentative conclusions can be drawn.

There is general agreement that a rise in blood urea and non-protein nitrogen occurs after burns, and our results are in conformity with this.

The very early rise in blood bilirubin (a pigment normally found in the bile and in slight quantities in the blood) is a striking feature of all the burns except those where the burn involves 5 per cent or less of the body surface. In some of the severe cases a hyperbilirubinæmia (abnormal quantity of bilirubin in the blood) was present a few hours after the burn. This might be attributed to breakdown of hæmoglobin in the burned tissue, a suggestion that has been put forward already by Cope and Rhinelander (1943), or to excessive hæmolysis, or to a very early failure of liver function. Judging from the bilirubin levels, any liver damage must have been small, as only four patients had a bilirubin of over 1 mg. per cent, and the

highest figure reached was 2.2 mg. per cent on one occasion.

The general opinion is that the correlation between the various liver function tests is disappointing.

From the few readings of blood sugar which we have taken, there is evidence of a very transient rise in blood sugar during the first few hours after burning, but not to the extent which might be expected from the results of animal experiments, *e.g.*, those of Clark and Rossiter (1944).

The absorption of sulphonamides from the surface of even deep burns is of considerable interest, as it gives direct proof that other soluble substances present in or on the burn may be absorbed into the circulation to a very considerable extent.

In conclusion, we would draw attention to the considerable variations in the responses of individuals burned to the same degree, and to the comparatively small alterations occurring in the chemical constituents even in severe burns.

Part VI. Postmortem Findings in Thirty Fatal Cases of Burning.

It has been stated (Pack, 1926) that "there are no internal or visceral lesions pathognomonic (decisively characteristic) of burns and scalds" and, while this is probably true, numerous authors have published conflicting reports describing various changes, notably in the liver and in the suprarenals, after burning. Many of the lesions described were probably due either to the local treatment adopted, *e.g.*, central liver necrosis after tannic acid (Wells, Humphrey and Coll, 1940; Erb, Morgan and Farmer, 1943) or to complications of burns, such as infection. The purpose of this paper is to record the postmortem appearances in a series of cases of burns in which tannic acid was not used and in which particular attention was paid to the prevention and control of infection. The majority of the findings have been negative, and no particular lesion has been found typical of death from burning.

For descriptive purposes, and because of a probable difference in ætiology (causes), it is convenient to divide the deaths into two groups: those which occurred during the "shock period"—which has been arbitrarily regarded as the first 96 hours after burning—and those which occurred after this time.

[The findings of this part are summarized. Ed.]

1. The postmortem findings in 30 fatal cases of burning injuries are described; 19 deaths occurred during the "shock period"; 11 at a later date.

2. In the patients dying within the "shock period," the most noteworthy postmortem features were:

(a) The absence of central lobular liver necrosis.

(b) The absence of damage to the suprarenals (except in one case).

(c) The occurrence, in cases of very extensive burns, of catarrhal changes in the renal epithelium, with the presence of various casts, including pigmented types, in the tubules (kidney damage).

(d) Oedema and congestion of the brain.

(e) The occurrence of punctate hæmorrhages in various organs.

3. The deaths after the "shock period" were due to the complications of burns or to intercurrent disease, rather than specifically to the burns themselves. The causes of death were as follows:

(a) Sepsis, hypoproteinæmia (less than normal protein in the blood) and anæmia, resulting from the presence of a very extensive raw area — 5 cases.

(b) Respiratory complications — 2 cases.

(c) Other causes — 4 cases.

Syracuse Factory Fire.

Fire, starting in the packing and shipping room on the first floor of the four-story sprinklered plant of E. C. Stearns & Co., Syracuse, N. Y., on April 6, 1945, destroyed this factory making hardware specialties for the war program. The fire spread with extreme rapidity and endangered near-by property. It was learned after the fire that three sprinkler valves controlling portions of the sprinkler equipment in the various sections of the plant were closed. In addition, a 30-pound piece of lead was found lodged in a tee in a sprinkler riser of the sprinkler system supplying upper floors of the building where the fire started. The loss, including use and occupancy, has been estimated at approximately $750,000.

Description of Property

The plant consisted of a main building of four stories in height, divided into three sections and covering an area 271 feet long and 60 feet wide. The northerly section was of brick, plank and timber construction and the central and southerly sections had brick veneer walls with mostly plank and timber floors and roof. To the west were located three additional communicating sections of varied brick, frame and concrete joisted construction. The plant buildings to the west of the main structures were two and three stories in height.

Fire Protection.

All of the important plant areas were equipped with either wet or dry pipe automatic sprinkler systems. Sprinkler spacing and pipe sizes mainly followed 1883-1896 schedules, but were supplied by strong water supplies. An unsupervised plant watchman made hourly rounds.

Story of the Fire.

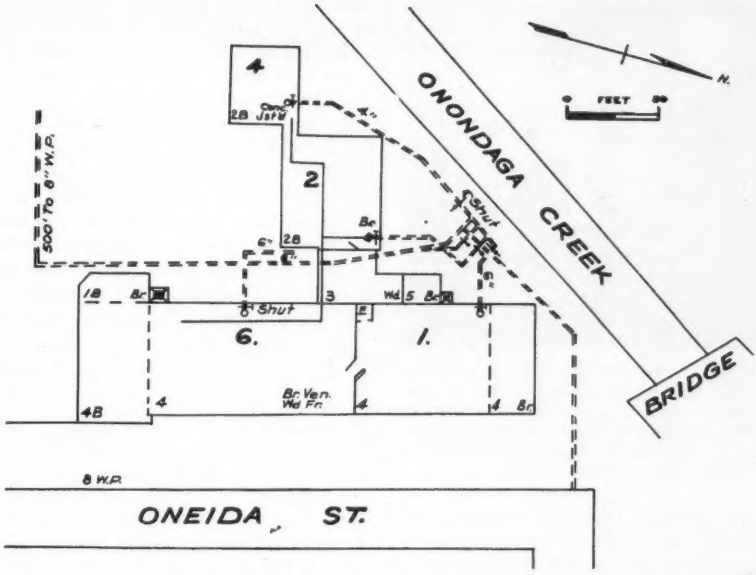
According to the watchman, the fire apparently started in a packing and shipping room in the first story of plant building No. 6. This was a four-story brick veneered section of the main building. The watchman ran to a near-by plant and telephoned to the fire department after having been forced to jump from a window to escape the fast spreading fire. This was at 5:45 A.M., which was perhaps fifteen minutes after he first noticed the odor of smoke. At about the same time some outside person operated a public fire alarm box.

The fire spread rapidly to adjoining and communicating buildings Nos. 1, 2 and 4 and the three-story frame connecting building, not numbered. The fire had gained considerable headway by the time firemen arrived, and shortly thereafter a mild explosion blew out a portion of the brick veneer wall of No. 6, injuring several firemen and damaging a pumper. The first alarm was followed promptly by a general alarm, bringing fifteen pumper companies, five ladder companies, a water tower, turret wagon, a lighting truck, and subsequently outside help was received from four neighboring towns. Some twenty-five hose streams were used in fighting the fire. Four hydrants were available within 300 feet of the plant, with others also near by on eight-inch circulating mains. An estimated 6000 g.p.m. was available at 75 to 80 pounds residual pressure for fire protection.

Sprinkler Protection.

Sprinkler equipment in the first floor of building No. 6 where the fire started was a dry pipe system. The upper floors of this building had wet pipe equipment. The dry pipe system was controlled by a dry pipe valve located in building No. 2. This valve also controlled sprinklers in buildings Nos. 2 and 4 and the small frame connecting building. A post indicator valve on the supply line to building No. 6 was found open after the fire, but a non-indicating gate valve under the dry pipe valve was closed. The clapper of the dry

For color photograph of this fire see Frontispiece.



Plan of E. C. Stearns and Co., Syracuse, N. Y., in which the fire occurred on April 6, 1945.

valve was not off its seat, although free. A non-indicating gate valve in the riser of No. 6 building and controlling sprinklers on the upper floors of this building was also found shut. A post indicator valve in the yard was open, as was a post indicator valve in the supply line to the wet pipe system in building No. 1, but a non-indicating valve in the riser of building No. 1 was about half closed. In addition to three sprinkler valves found either totally or partially closed, a piece of lead was found lodged in a 6 x 4 x 3 in. tee in the riser below the closed valve controlling the wet pipe sprinklers in the upper stories of building No. 6. This lead was 4½ ft. long by 3½ in. wide, tapering to 2 in. at one end, and was ½ to ¾ of an inch thick. At the butt end of this obstructing lead was attached another piece 21 in. long, 5 in. wide, tapering to 2 in. and also ½ to ¾ of an inch thick. This lead would have been a serious obstruction to water supplies under normal conditions of sprinkler operation. The lead probably entered the pipe due to faulty pouring of lead joints in underground piping. However, the heavy loss from this fire was due to the sprinklers being shut off for an unknown reason. The length of time the sprinkler system had been out of service is not known. The housekeeping and maintenance of fire protection equipment at this plant had previously been reported unsatisfactory and the destruction of the plant is the obvious result of lack of maintenance of automatic sprinkler protection.

It is probable that the fire had considerable headway before discovery by the watchman. The electric alarm on the dry pipe sprinkler system was inoperative because the system was shut off.

Record Vault Performance.

One interesting factor in this fire was the performance of a two-story fire-resistive record vault. This vault covered an area of 15 x 18 ft. The first story walls were of 12-in. brick plus 4-in. hollow tile

View of the two-story brick and tile record vault which preserved its contents at the second floor level despite damage by falling debris, but failed to protect contents in the first floor area due to failure of single, unapproved fire door.

on the interior. The second story walls were of 8-in. brick plus 4-in. hollow tile. The vault floors were concrete on the first floor grade, and 8-in. brick arch sprung between 4-in. steel railroad rails, with lower flanges exposed for the second floor. The rails ran east and west with ¾-in. tie irons placed north and south through the walls. The arch was topped with 2 to 5 in. of lime mortar mixed with 2 in. thickness at top of arch running through the wall at the door, forming a threshold for the second floor. The roof construction was similar to the second floor. The opening for the first floor was protected by a single unapproved tin-clad fire door swinging inward and on the inside of a metal clad casing. The second floor vault had double swinging steel safe doors, with the outer door overlapping about 1½ in. all around. After the fire the first floor vault door was found open and damaged. Old papers and records contained in the first floor vault were destroyed. The doors on the second floor were intact and a torch was used to burn around the bolt to gain access. The contents of the second floor of the vault consisted of active office and plant records which were not damaged.

The vault was exposed to extremely high heat on all sides and overhead for a period of 8 to 10 hours with added exposure to smoldering debris and rubble for some time afterward. The only structural damage noted was at the roof on the northwest corner, where the corner was slightly knocked off, apparently by falling debris. This is shown in the photograph, but no damage resulted to contents of second floor.

This report is based upon information furnished by Superintendent B. R. Martin, Syracuse, N. Y., New York Fire Insurance Rating Organization (member N.F.P.A.), Assistant Manager W. D. Milne, Eastern Inspection Bureau (member N.F.P.A.), Chief Frank M. Savage, Syracuse Fire Department, Inspection Department, Associated Factory Mutual Fire Insurance Companies (member N.F.P.A.), and other sources.

Chicago Lumber Fire.

Fire protection engineers have long been accustomed to large losses in lumber mills and woodworking plants, because of the huge areas of combustible construction without effective subdivisions and without adequate exposure protection between the plant buildings. All too frequently outside lumber storage areas serve as a means of communicating fires from building to building. That such properties are subject to total destruction by fire, even when equipped with automatic sprinkler protection and when located in the heart of a large city with powerful municipal fire forces available, was demonstrated by the fire which destroyed a group of mill and lumber companies in Chicago on the afternoon of Wednesday, April 11, 1945. The loss, including use and occupancy and rent, was close to $700,000.

Description of Properties.

The building in which the fire started was of one equal to two stories frame construction with a ground floor area exceeding one and one-half acres (325 ft. by 225 ft.). The floors consisted of earth, concrete on ground, and 1 inch ordinary joist with air space. Walls and ceilings were partially sheathed. The chief occupant of this building was the Red River Lumber Company. The White Pine Lumber Company occupied a portion of the structure as well as a near-by frame lumber storage shed 200 feet long and 50 feet wide, equivalent to two stories in height. Other frame buildings involved in the fire were occupied by the Lillie Lumber Company and the J. W. Landis Mill Company. The only brick constructions involved were a shavings vault and a small office structure. Yard areas were enclosed by a 9-foot fence along the street front.

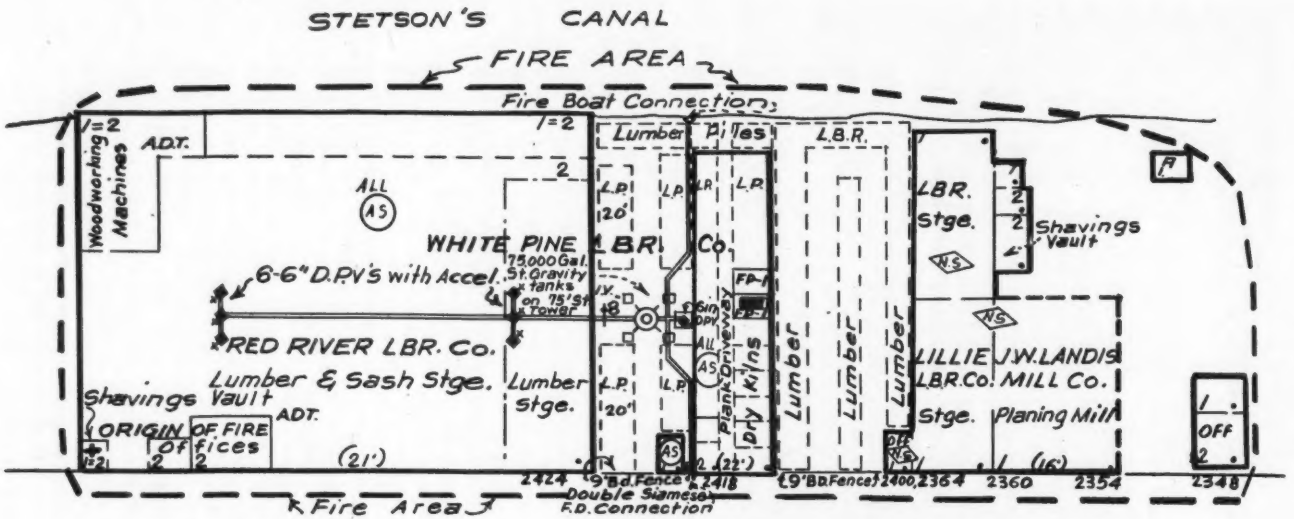
Fire Protection Facilities.

The Red River Lumber Company premises in which the fire started were protected by a dry pipe automatic sprinkler system supplied by an 8-inch main connected to a 75,000-gallon steel gravity tank on a 75-foot steel tower. There were, however, numerous unsprinklered wooden decks in the Red River Lumber Company plant. Local sprinkler alarms consisted of inside and outside bells. First aid fire protection was provided by chemical extinguishers and water barrels and pails. The building occupied by the J. W. Landis Mill Company and the Lillie Lumber Company covered 20,300 square feet in area and was without automatic sprinkler protection. A dead end 6-inch water main supplied hydrants on South Loomis Street at the front of these properties. This main, admittedly inadequate for a fire of such magnitude, was of little value, because the intense heat made the hydrants near the building untenable.

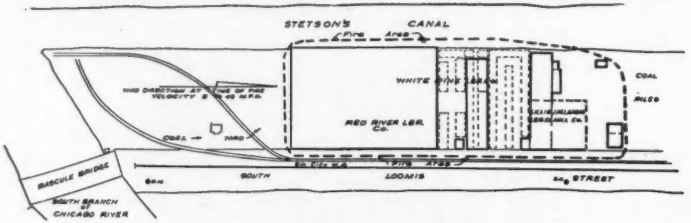
Story of the Fire.

About 2:15 on Wednesday afternoon, employees detected smoke in the sawdust and shavings room at the southeast corner of the Red River Lumber Company building. They found bagged sawdust on fire and applied first aid fire appliances. It was stated that bagged sawdust carried from the building burst into flame when the bags ruptured. A wind of gale proportions was blowing and apparently carried the fire into concealed spaces. Shortly afterward, the fire broke through the south wall.

Twenty minutes after the fire was first detected, an alarm was telephoned to the fire department. An engine and a ladder company were dispatched. Upon arrival, the Battalion Chief in charge attempted to call additional help over the telephone in the Red River Lumber Company office, located close to the shavings vault near where the fire started. However, the fire was spreading so rapidly, he was forced to escape through a window before completing the call. Due to the velocity of the wind into the north driving the flames along Loomis Street, only the first engine company was able to approach the fire from the northerly direction due to the intense heat. Other apparatus was instructed to approach from the south side of the Chicago River. As additional ap-



Scale — ½ in. = 50 ft.



Plan showing fire area of Chicago lumber fire, April 4, 1945.

Turret nozzles in operation at the Red River Lumber Company fire.

paratus arrived, suction was taken from a slip adjacent to the plant and from hydrants south of the river, as well as from a street some distance further north from which streams were supplied by pumpers operated in relay. Within twenty minutes after the arrival of the apparatus, the entire group of frame structures was destroyed. One piece of fire apparatus and many lengths of hose were damaged. The fire department responded to five alarms supplemented by three special calls for additional equipment, making a total of eight alarms.

Several hours prior to this fire, many fire companies were engaged in fighting a fire in a lumber yard in another part of the city. The extent of the extra alarm fires in addition to the usual number of alarms required the response and relocation of approximately 70% of the city's fire apparatus, and complicated the alarm and relocation assignments.

Cause and Loss.

The exact cause of the fire has been the subject of conjecture, with one theory that it was due to spontaneous ignition of sawdust from lumber that was damp when sanded. Another theory was that the lumber had been treated with a wood preservative that stimulated spontaneous ignition of the sawdust. Loss to buildings was approximately $118,000, loss to contents about $513,000. Use and occupancy, rent, machinery improvements and betterments losses may total another $66,000. In addition, there was loss to adjacent high tension lines, transformers and poles.

Conclusion.

Despite the strong wind that was blowing in the large areas of frame construction, it was considered likely that the fire department might have been able to confine the fire had the alarm been given promptly. Investigation after the fire showed that automatic sprinkler equipment had operated, but sprinklers were handicapped by the strong wind and concealed spaces. A properly constructed shavings vault remote or cut off from the balance of the plant would have made such a fire improbable.

NOTE: This account is based upon data included in a report by the Cook County Inspection Bureau (member N.F.P.A.), and other sources.

Pyroxylin Lacquer Plant Fire.

Fire, starting in a congested storage yard area containing drums of flammable liquids and scrap film, destroyed the lacquer manufacturing plant of the H. & C. Laboratories, Inc., in Mansfield, Mass., on April 12, 1945. Sprinklers in the plant buildings were ineffective due in part to an inadequate water supply. The contents of outside flammable liquid storage tanks which were improperly vented, exploded. The entire property was destroyed with the exception of 200 full drums of flammable liquids within reach of hose streams. The loss has been estimated at $96,000 to buildings and contents, with a substantial use and occupancy loss likely.

This fire is of particular interest as an example of the result of lack of observance of the standard precautions for fire safety as presented in the N.F.P.A. pamphlet "Suggestions for Lacquer Manufacturing Plants" and in other N.F.P.A. standards. Processes involving flammable liquids and hazardous chemicals on the premises of large manufacturing concerns are commonly found to be well safeguarded. Smaller plants such as the one involved in this fire, however, all too frequently are operated with apparent complete lack of regard for the elementary principles of fire safety. There should be every opportunity in the small community where ample land is available to isolate hazardous storage from manufacturing buildings, and by subdivision and separation of individual units minimize the extent of loss in any single fire, even though it may not be possible to provide fire protection on a scale commonly specified for such operations in larger plants where ample water supplies and other fire protection facilities are available.

Lacquer Manufacturing.

Lacquer manufacturing was carried on in a one-story concrete block main building with joisted roof. There was also a one-story frame storehouse containing empty drums and spare machinery and a small boiler house. The plant operations consisted of dissolving nitrocellulose and scrap film in various solvents. The equipment included three elevated mixing tanks with impellers, seven copper kettles and two large floor-level mixers. The mixing equipment was protected by a permanently piped carbon dioxide system with manual controls located near the main door. Electrical equipment was of a type suitable for hazardous locations. There were two 50-lb. portable carbon dioxide extinguishers in the main building.

Solvent Storage.

Solvents used included ethyl acetate, butyl acetate, iso propyl acetate, alcohol, acetone and low flash naphtha. Part of these solvents were stored in nine 5000-gallon elevated horizontal tanks outside of the main building. The rest were in the yard about the plant in drums. The elevated tanks contained about 32,000 gallons of solvents and the drums held approximately 26,000 gallons. Nitrocellulose with alcohol was also stored in drums at several locations in the yard, as were drums of scrap nitrocellulose film dissolved in solvents.

While moving empty drums from a large pile to make room for two new 5000-gallon storage tanks at the south end of the plant, an employee noticed a small fire. According to the fire department, fire started on residue remaining on the heads of empty drums which had contained scrap film. It is believed that fire was due to a spark struck while the drums were being moved. The workman ran to the main building for help. The Mansfield fire department could not be reached by telephone as at the moment the line was open for a long distance call. An employee was sent to a public fire alarm box 300 yards away, but in the meantime the fire department had received a call by another telephone. The fire spread so rapidly that workmen were unable to place

Only a few drums of solvent remained after fire destroyed this lacquer manufacturing plant in West Mansfield, Mass.

streams in operation from the yard hydrant and hose house, which were seriously exposed by the flammable liquid storage and inaccessible early in the fire. Within five minutes the fire had traveled through the drum storage area on the west side of the plant, had ignited plant buildings and had extended through drum storage area to the east of the yard. Half an hour after the start of the fire, the contents of the elevated storage tanks began to burn. Due to the operation of numerous sprinklers and broken sprinkler piping, the fire department could obtain little water from hose streams because sprinkler shut-off valves were not immediately accessible. Many minor explosions sent nitrocellulose and solvent drums flying into the air, and explosions of elevated storage tanks threw several of these tanks a considerable distance — at least one of the tanks being thrown a distance of 200 feet.

Due to the indiscriminate storage of the various flammable solvents, with little or no attention to segregating the various types of storage or maintaining piles of reasonable size, it was impossible to control the fire. The 5000-gallon storage tanks were not equipped with flash arrestors in the vents, and solvents were drawn from the bottom of the tanks by gravity flow. A shallow ditch had been dug around the storage tanks to conduct any minor leakage to near-by swamps, but was not adequate for a major tank failure. The bursting of nitrocellulose and solvent drums threw flames a considerable distance.

Only one public hydrant was available in the plant area. Before public fire departments could get two effective streams, it was necessary to shut a gate cut-off at a sprinkler supply main to the plant, as well as the west section of the town. Another pump took suction from a near-by brook and provided two streams which were used to extinguish burning brush in near-by woods.

"The entire facilities of this new plant now going to . . ." Revision of the wording of the signboard before the Shreveport plant of the Brewster Company seems to be in order as flames sweep through the property.

Recent Large Loss Fires in Bomb Plants.

Stupidity and carelessness of workmen and disregard of some of the basic tenets of fire prevention and fire protection on the part of management produced large losses last May at two war plants engaged in the manufacture of bombs and bomb parts.

The first of these occurred May 4, 1945, at Shreveport, La., when the new plant of The Brewster Co., Inc., was severely damaged by a fire which was started from oxy-acetylene cutting operations by unintelligent workmen. That these cutting operations were merely "the straw that broke the camel's back" will become obvious as this report progresses.

The building involved was a single-story structure having an undivided floor area of 56,000 sq. ft. (43,560 sq. ft.=1 acre). The lower part of the walls was brick on which were erected wired glass windows in metal frames surmounted by an asphalt and asbestos protected metal siding and a peaked roof of the same material on metal trusses and supports. The floor was concrete. The building was erected during 1944, and shortly after the first of the year, the production of 250-pound bomb casings was in full swing. There were no automatic sprinklers, no standpipe and hose, no trained fire brigade.

Stored in this building, in a huge pile which extended upwards to the eaves, were several thousand bomb bands. These bomb bands were made of paper, rolled into rings, impregnated with paraffin and were intended to be pressed on to the bombs to protect them during shipment. These bands were formerly made of steel, but to conserve metal, the government recently changed to paper. There were also eleven 40,000-lb. carloads of these bomb bands stored just outside the building.

On the day of the fire, workmen were engaged in erecting an addition to the south side of the building. Iron workers employed by the contractor had climbed to the top of the pile of bomb bands to burn holes with an acetylene cutting torch so that new structural members might be installed. Apparently, they were totally ignorant of the fact that molten metal is hot enough to ignite paper and went right ahead with their cutting operations without bothering to take any precautions whatsoever against fire. Sparks and globules of molten metal promptly ignited the bands, and the fire spread over the pile with great rapidity as might be expected. All efforts of plant workmen to extinguish the fire with several carbon dioxide hand extinguishers were in vain. The fire spread through an open doorway to the bomb bands piled outside. A strong breeze, estimated at 20 m.p.h., drove the heat and flames toward the building, and this was supplemented by the operation of several large fan ventilators in the roof, which drew the heat and flames inward and upward. The heat caused the asphalt binder and coating of the protected metal to vaporize and these vapors were ignited over the entire inner and outer surface of the building in course of ten to twenty minutes. The heat was well above the flash point of asphalt and is shown by the fact that the wired glass windows melted at between 1200° F. and 1400° F.

The Shreveport Fire Department received its first call by telephone at 11:32 A.M., or about seven minutes after fire started. The fire department responded immediately with four pumpers. It is reported that flames 25 to 30 feet high were coming out of the ventilators when the firemen arrived. Some delay resulted when a pumper was connected to one of the hydrants nearest the plant (375 feet) and it was then discovered that the main was broken near the hydrant. This pumper was then shifted to another hydrant 600 feet from the plant. Four pumpers with

Columbus, O., Fire Dept.

View of damage to the Blaw Knox plant after the fire of May 6, 1945. Roof has collapsed over the paint spraying area. Fire started about 100 feet to the right of this scene. Note the pile of Navy anchor chain links in the foreground.

one stream each were then pumping on the fire with a total of 3250 feet of hose laid. It is said that the firemen were reluctant to enter the building lest it collapse or some of the bombs explode. The bombs were not loaded and there was no actual danger of explosion at any time, although obviously the firemen did not know this at the outset. Fire fighters were handicapped by an inadequate water supply. Water mains in the vicinity were only four inches in diameter, with flows of about 300 g.p.m. available at hydrants. The fire was fought thirteen hours before it was finally extinguished. The heavy machinery of the plant was little damaged and production was resumed within a few days.

The direct loss from this fire has been estimated at about $292,000. The indirect losses resulting from loss of bomb production, destruction of several carloads of finished bomb cases, and the destruction of about 75 per cent of the bomb band supply is not calculable. There is small satisfaction in conserving new paper and saving waste paper to make war products which are then destroyed by needless fire.

Two Days Later Another Plant Burned.

The second bomb plant fire occurred on May 6, 1945, at Columbus, Ohio, when the Blaw Knox Company experienced a devastating loss. Here again, although the fire was started through the carelessness of a workman, the true causes of the large fire are much more deeply seated.

The building involved was formerly used by another concern for spray painting and drying of railroad box cars. It was of steel frame construction, with brick walls and asphalt and asbestos protected metal roof on steel trusses. The building had an undivided floor area of more than 52,000 square feet and there were several additions which were mostly of frame construction. There were no automatic sprinklers, no standpipe and hose. First aid fire appliances were available.

The company maintained no fire brigade, but the owners and lessors of the building who occupied the adjacent property did have a fire brigade which would respond on call. The entire property is located just over three miles from the nearest engine company of the Columbus Fire Department. The Blaw Knox Company was engaged in the manufacture of

Columbus, O., Fire Dept.

This shows damage to opposite side of the Blaw Knox plant. Observe the cluttered condition of the surrounding property.

rocket bomb parts and anchor chains for the U. S. Navy. Operations in the manufacture of bombs included metal machine work, cleaning and spray painting. Anchor chain manufacture involved electric welding, grinding, heat-treating, and paint dipping.

In the hazardous area, sawdust and shavings were used to absorb oil and solvent (flash point 104° F.) and covered a considerable area of the floor. There was a considerable accumulation of residue in the paint spray booths and exhaust ducts. There were no waste cans for oily rags.

On Sunday, May 6, there were about sixty employees in the plant. Most were engaged in maintenance work, but some were engaged in production of rocket bomb tubes in the threading department. During the latter part of the afternoon one of the workmen felt the need of a smoke and proceeded to light up. It is reported that smoking was permitted throughout the plant except around the painting and dipping areas. He used an ordinary "strike anywhere" match which chanced to break, the lighted head falling on oil and solvent soaked sawdust on the concrete floor near one of the thread-gauging benches. He and other employees tried to stamp out the small fire in the sawdust, but this effort was unsuccessful and actually spread the flames. Various types of extinguishers were used to no avail. Employees were for the most part unfamiliar with the proper operation of the various extinguishers and it is evident that they were not used effectively. Some of the extinguishers contained water solutions and reports state that the burning sawdust floated on the liquid, increasing the area of the fire until it reached the spray booths. The under side of the roof, which was twenty feet above the floor at the eaves, soon became ignited, within one minute, according to witnesses. As the fire continued to spread over roof and floor, burning asphalt dripped from the roof, igniting oil coating on metal parts, packing containers, wooden platforms and other combustible material. It was then that the building was evacuated and the fire department called.

It is difficult to estimate how much time elapsed before the private brigade and public fire department were called, but employees are quoted as reporting that the delay may have been as much as twenty-five minutes. The Columbus Fire Department received the first alarm from a public

alarm box 800 feet from the plant at 4:39 P.M. Simultaneously a telephone call was received from an employee, who reported, "There's a fire at the Blaw Knox Company! Send everything you've got!"

On arrival at 4:44 P.M., the fire department found that the lessor's private fire brigade had one stream in operation. A third alarm was immediately transmitted by radio. The building could not be entered and immediate efforts were directed to confining the fire and protecting adjacent property. The fire was fought with a total of sixteen hose streams and was finally extinguished about five and a half hours after it started.

Although the fire involved the entire roof, destroying the coating materials and rendering the metal sheets useless, only that portion directly above the painting operations collapsed. The building walls and many of the steel columns remained standing, but their salvage value is questionable. Loss to the building is estimated at 80 per cent. The machinery and equipment were for the most part individually electrically operated and were severely damaged, as were the electric chain welding devices, which were subjected to severe heat from the near-by painting area. The inventory was large and of increasing value. A substantial share of this inventory consisted of rocket bomb parts, machined to close tolerances, and salvage is doubtful.

Columbus, O., Fire Dept.

Detail view of the damage to the asphalt-asbestos protected metal roof.

The loss to the building has been estimated at a little over $100,000 and the loss to machinery and building additions at more than $300,000. The loss to stock has been placed at approximately $1,650,000, making the total estimated loss from this fire more than $2,000,000. So far as is known, no use and occupancy insurance was carried.

Conclusions.

There do not appear to be any new lessons to be learned from either of these fires. Any fire protection engineer could have predicted devastating losses at both plants after even a cursory examination of the properties. There can be no doubt that the asphalt-asbestos protected metal construction of the buildings contributed to the extent of the damage, particularly in the Columbus fire, but in both cases even without the construction factor, the stage was set for an inferno.

The fact that asphalt-asbestos protected material was involved in both of these fires focuses attention upon this material. The experience in these and similar fires indicates that this material may have been widely used without proper understanding of its fire properties. The designation "asbestos protected" may lead the layman to feel that this material is safe from fire. Actually the asphalt binder used furnishes fuel for fire, though probably not enough fuel to constitute a hazard in an otherwise non-combustible occupancy. However, as shown in these fires, when there is a hot fire in a combustible contents building there is sufficient heat to ignite the asphalt binder and this contributes to the spread of flame. It is interesting to note that in neither of these fires was there any extensive collapse of structural steel roof members. This indicates that despite the apparent intensity of fire, the actual severity was not comparable to fires involving wood roofs on structural steel trusses, as in such cases the trusses commonly collapse as a result of heat. It thus appears that there should be no objection to the use of asphalt-asbestos protected metal construction if employed with proper understanding of its burning properties, and if adequate protection such as an automatic sprinkler system is provided where the building has some combustible contents.

SOMEONE CLOSED A SPRINKLER VALVE

...and what might have been a minor outbreak developed into a major disaster.

BECAUSE SOMEONE had closed a post indicator valve shutting off the water that would have supplied the automatic sprinkler system —this Cedar Rapids, Iowa, plant was completely destroyed on October 15, 1944, with a loss estimated at $250,000.00.

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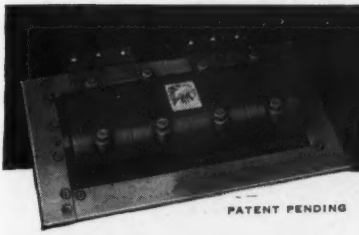

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A Powerful New Fire Prevention Device That Really Works!

"Cause of Fire—Tramp Metal in Materials"
How often we see this comment in fire reports!

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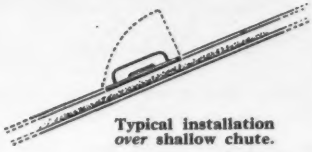
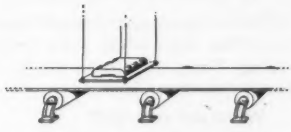
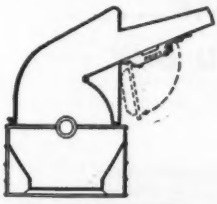


Typical installation *over* shallow chute.



The Eriez installed *above* belt conveyor.



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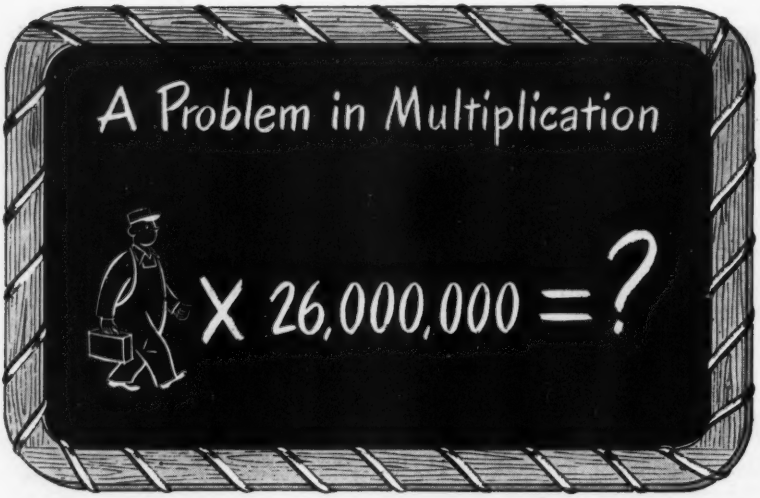

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It's sudden death to flames, of course—in flammable liquids or electrical apparatus—but that's just *one* of the outstanding advantages of Kidde equipment.

Equally important: dry, inert carbon dioxide gas—the fast, sure extinguishing agent used in Kidde equipment—is *completely harmless* to materials and machines.

Carbon dioxide gas cannot contaminate or dilute valuable liquids. Used on electrical fires, it will not soften or water-soak insulation. It's a non-conductor too—there's no danger of short circuits, or of shock to the operator. And there's no after-fire mess to be cleaned up.

Kidde portable extinguishers for small, isolated blazes in flammable liquids and electrical equipment; wheeled units and built-in systems for major hazards—all are deadly to fire, and *only* to fire. The Kidde line includes the *right* kind of protection for every tough-fire hazard in the accompanying list...ask a Kidde representative for full information—he's skilled in the ways of fire protection.

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KIDDE KILLS TOUGH FIRES *in Process Rooms, Ovens, Spreaders, Motors, Storage Rooms, Mixers, Coaters, Transformers, Dip Tanks, Agitators, Washing Trays, and Control Panels.*

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Economy in installation cost and maintenance has dictated the consistent policy of Star Sprinkler Corporation in distributing its Fire Protection Devices through local licensed contractors who have had a lifetime of experience in the installation of automatic sprinkler systems. Operating throughout the United States, Canada and South America, Star licensees, due to their strategic locations, can render instant service. Write us for name and address of Star licensed contractor nearest your location.

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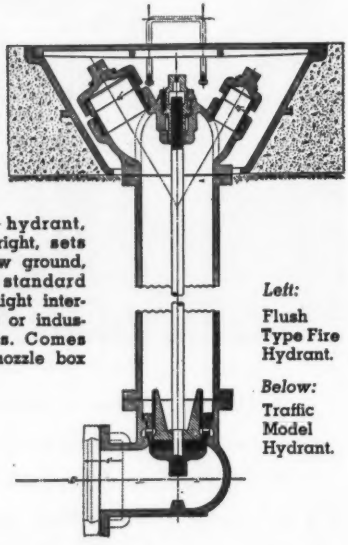

Flush type fire hydrant, illustrated at right, sets completely below ground, is used where standard type hydrant might interfere with traffic or industrial operations. Comes with cast iron nozzle box and cover.

Left: Flush Type Fire Hydrant.

Below: Traffic Model Hydrant.

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M & H Fire Hydrants are dry top and revolving head. They are easy to lubricate. Maintenance costs are low due to simplicity of design and rugged construction. They have low friction loss and great efficiency because barrel diameter is not reduced and there are no working parts or obstruction in waterway. Special Traffic model is designed to yield at the ground line under impact. Repair is simple and easy.

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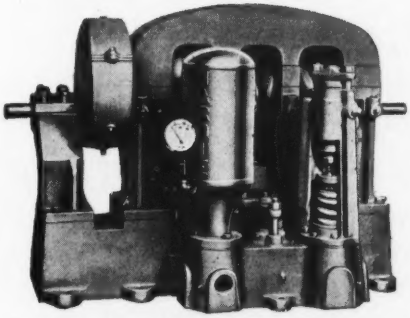

● Hardie pumps for Fog Fire Fighters are available in two sizes. The Hardie LCXA (at left) delivers 60 gallons per minute at 800 P.S.I. at 130 R.P.M. The Hardie XCXX delivers 35 gallons at 800 P.S.I. at 118 R.P.M.

● Efficiency of any Fog Fire Fighter depends squarely upon the pump and the gun. Hardie offers perfected, proved quality in these two basic factors. Hardie pumps give you 800 P.S.I. for long, sustained periods without overloading or excessive wear of operating parts. The Hardie Fog Gun delivers a true fog—the finely atomized spray that makes this new method of fire control most successful.

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Tomorrow, **with extensive war experience, we will be better equipped to serve the post-war world.**

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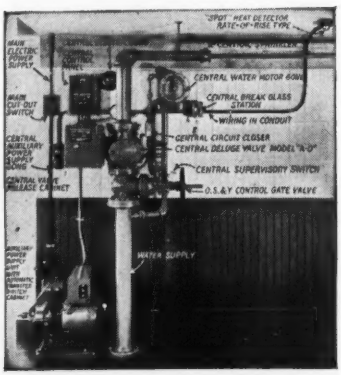

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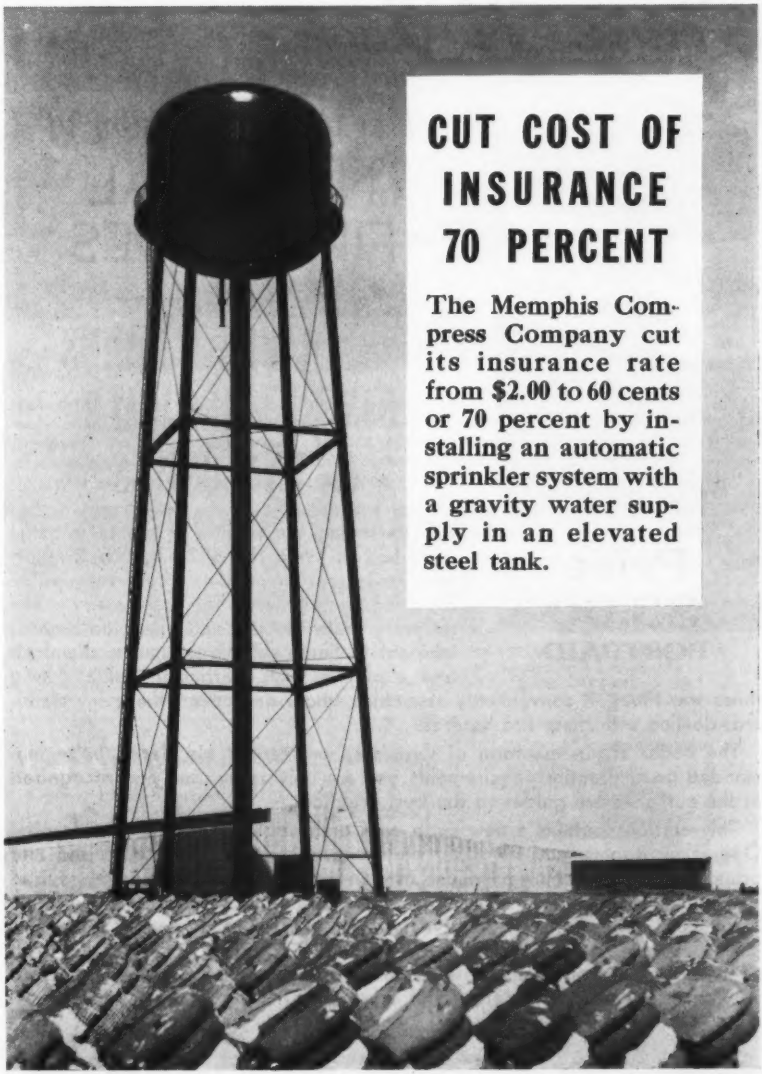
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70 PERCENT
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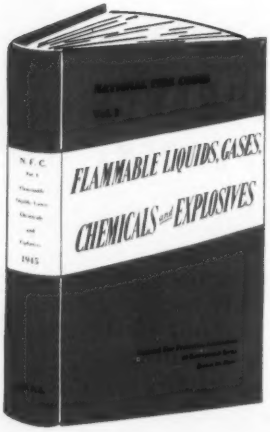

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Superseding the volume of the same name published in 1943, this 592-page book meets an ever-increasing need of those responsible for safeguarding human life, private and public property from the fire and explosion hazards inherent in flammable liquid gases, chemicals and explosives. Of particular value during these war times, it conveniently assembles, under one cover, the many standards dealing with these fire hazards.

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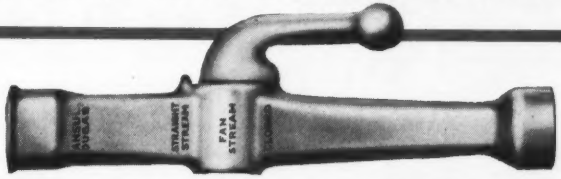
NOW... NEW DUAL-STREAM NOZZLE
further steps up fire-killing punch of
DUGAS EXTINGUISHERS!



NEW DUAL-STREAM NOZZLE deals effectively with spill fires and fires difficult to reach because of height or obstructions. Designed for use with DUGAS wheeled extinguishers, the new Dual-Stream Nozzle greatly increases fire fighting range and effectiveness. A turn of the handle gives a *straight* stream with a range of 45 feet—or a *fan* stream with a range of 15 feet.

STRAIGHT STREAM of fire-killing DUGAS Dry Chemical permits a large fire to be knocked down from a safe distance before operator goes in to extinguish it.

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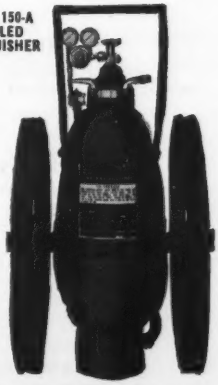

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Viking Sprinkler Systems go into action with the speed of a Fire Department in your own plant. In peace and war Viking Sprinkler Systems are protecting industrial plants across the nation against the universal enemy of production . . . . FIRE. There is a Viking dealer near you to give you all the facts.

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Philadelphia, Pennsylvania

Viking Automatic Sprinkler Co.
Seattle, Washington

Viking Automatic Sprinklers, Ltd., Toronto, Ontario, Canada

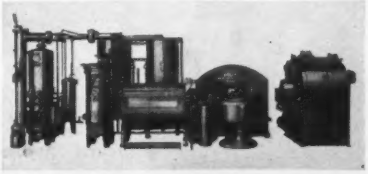
Viking Automatic Sprinkler Co., San Francisco, California

THE VIKING CORPORATION
HASTINGS, MICHIGAN

. . . TO TRY TO GET 140-F BENEFITS FROM HIGH-FLASH SOLVENT ALONE!

Fire prevention authorities and dry-cleaning experts agree; it's not high flash solvent alone—nor Underwriters Laboratories approved machinery alone—but the combination of the two—that produces complete drycleaning safety. Due to wartime shortages, some attempts have been made to use high-flash petroleum solvent in equipment lacking approved safety features. Such makeshifts are to be deplored.

Drycleaners using Hoffman 140-F drycleaning systems are able to continue their legitimate operations—using 140-F Class III machinery with listed high-flash solvents.



U. S. HOFFMAN MACHINERY CORPORATION
105 Fourth Ave., New York 3, N.Y.
DRY CLEANING LAUNDRY & GARMENT PRESSING EQUIPMENT

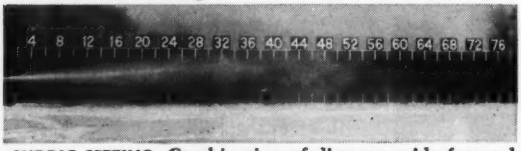
THE REAL STORY OF FMC

Don't confuse the results obtainable from FMC High-Pressure Fog Fire Fighting with any other system. There's nothing else like it for efficiency, for speed, for all-type fire protection.

These unretouched photographs show various applications of high-pressure fog as it is actually discharged from a standard FMC Fog Fire Gun. Several of the many settings are shown proving the true carrying power and steam-like fog that is usable for the speedy, efficient quenching of various types of fires. The standard capacity of one gun (two guns per unit) is 30 gallons per minute at 600 lbs. gun pressure.

All of our claims for the effectiveness of high pressure refer only to the FMC System.

WIDE FOG CLOUD. Not a hollow cone spray, but a fine dense fog with a harmless amount of entrained air at the blaze. Has an effective range of 20 to 24 feet. Imagine fighting a fire with this closely-packed fog! The fire couldn't help but cool down and smother out, and without water damage.



MIDDLE SETTING. Combination of distance, wide fog and density. Not a hollow cone! Has long range effectiveness of 30 to 40 feet. No harmful entrained air at the blaze. Very effective—reaches fire without endangering firemen. One man can handle easily. Fires can be put out without usual water damage.

LONG RANGE STREAM. Necessary only for great distance. Has reach of 50 to 60 feet. Has tremendous carrying power, penetration and effectiveness. Still is fire-fighting fog—making every gallon do maximum work. Used to reach "hard-to-get-at" fires. Uses much less water. No harmful entrained air at the blaze. One man handles gun and hose in moving around at fire.

BUILDERS OF BEAN HIGH-PRESSURE

HIGH-PRESSURE FOG FIRE FIGHTING

The Modern Way of Fighting Fire. The FMC High-Pressure Fog Fire Fighting System—originated by the John Bean Mfg. Co.—has revolutionized fire-fighting technique. *It's the Pressure that Counts!* In fighting fire with fog—you must have high pressure. And that's what you get with the FMC Fog Fire Fighter.

The FMC High-Pressure Pump packs the needed punch to produce and maintain *800 lbs. pump pressure*—better than *600 lbs. nozzle pressure.*

A Little Water Goes a Long Way! The high pressure gives you a combination of high velocity and finely-atomized water—just what you need to *blast—cool* and *smother* flame.

One gallon of this finely-atomized fog—properly used—has the fire-quenching possibilities of many times that of low-pressure water. Get the facts! FMC High-Pressure Fog is one of the greatest contributions ever made to fire fighting. Write today — for complete information.

★ ★ ★

STANDARD FMC FOG FIRE FIGHTER. A self-contained fire fighting unit. Carries its own water supply and complete fire-fighting equipment. Provides two guns of 30 gallons each at 600 lbs. nozzle pressure.

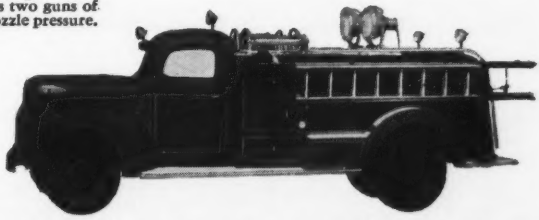
FMC FOG FIRE GUN

Built Only by Bean

The FMC Fog Fire Gun is designed especially for high-pressure work.

Note these Features:

1. **PROTECTIVE SPRAY.** Special spray protects face and shoulders from heat.
2. **ADJUSTING BARREL.** By turning barrel, flow can be changed from a straight "power" stream to a close-up fog for any type of fire.
3. **TRIGGER GRIP.** Gives natural position to arm and grip and is easy to hold.
4. **GUN LOCK.** Stream can be set in any pattern and locked there if desired.
5. **HOSE SWIVEL.** Eliminates bothersome twisting of hose.



FMC *Original* HIGH-PRESSURE FOG FIRE FIGHTER

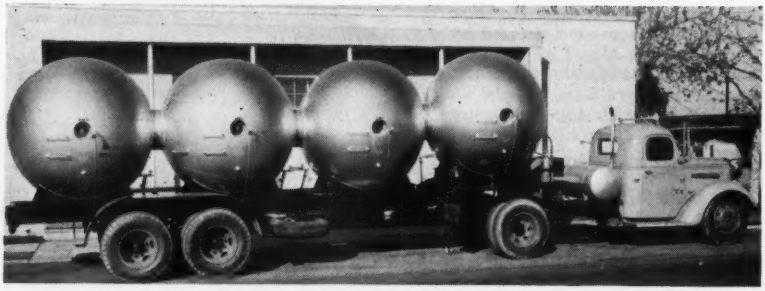
CAN BE MOUNTED ON MOST STANDARD TRUCK CHASSIS

FOOD MACHINERY CORPORATION

John Bean Mfg. Co., 739 Hazel St., Lansing 4, Mich. • Bean-Cutler Division, 439 Julian St., San Jose, Calif.

PUMPS FOR OVER SIXTY YEARS

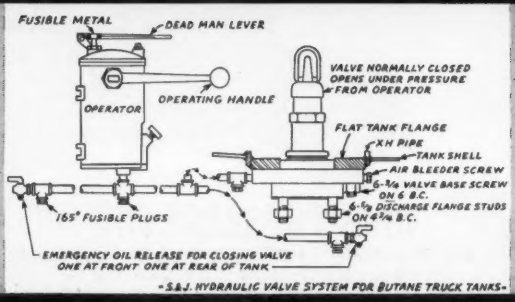
PROVEN SAFETY IN A NEW FIELD



For many years S. & J. Hydraulic Internal Safety Valves have provided the maximum protection to load, equipment, personnel and property in the safe delivery of gasoline. Because of the very nature of Liquefied Petroleum Gases they present additional hazards which must be guarded against. L. P. G. transporters and tank builders are displaying real ingenuity in the designs of their transport equipment, and S. & J. engineers have provided additional factors of safety in the Hydraulic Internal Safety Valve system as illustrated below. Complete details and consultation available to all fire prevention authorities.

SHAND & JURS CO.

BERKELEY, CALIFORNIA • New York Chicago Houston Los Angeles Seattle


FUSIBLE METAL
DEAD MAN LEVER
VALVE NORMALLY CLOSED OPENS UNDER PRESSURE FROM OPERATOR
OPERATOR
OPERATING HANDLE
FLAT TANK FLANGE
XH PIPE
TANK SHELL
AIR BLEEDER SCREW
6-3/8 VALVE BASE SCREW ON 6 B.C.
6-1/8 DISCHARGE FLANGE STUDS ON 4 3/4 B.C.
165° FUSIBLE PLUGS
EMERGENCY OIL RELEASE FOR CLOSING VALVE ONE AT FRONT ONE AT REAR OF TANK

"S & J. HYDRAULIC VALVE SYSTEM FOR BUTANE TRUCK TANKS"

SHAND & JURS

Fire Fighting Blizzard

by

NATIONAL FOAM

Fire is unpredictable, like the weather, but there is nothing uncertain about the man-made "blizzards" of tough, clinging, fire-smothering foam produced by National Foam. It's there when and where you want it—as a gas-tight blanket of Aer-O-Foam—to snuff out flames and prevent flashbacks.

The U. S. Navy calls Aer-O-Foam "bean soup"—with respect. Easily and quickly applied, it is a veritable blizzard of thick, tenacious bubbles smothering the immediate surface afire—without interference with other activities.

Fire strikes in season and out. Aer-O-Foam "blizzards" are available the year around.

IN FIRE DEPARTMENT SERVICE

National Foam System has equipment especially designed for use of Fire Departments to meet all types of foam fire fighting requirements.

BACK THE ATTACK
BUY WAR BONDS

NATIONAL FOAM SYSTEM, INC.

SPECIALIZING IN FOAM FIRE PROTECTION

Packard Building, Philadelphia 2, Pa.

Positive SQUEEZ-GRIP *KILLS FIRE in seconds*

Here in four simple hand movements we come to grips with modern fire protection. Carbon dioxide gas, the fastest non-damaging fire extinguishing agent, is stored under high pressure in portable cylinders. The rapid release of the fire killing gas with the new SQUEEZ-GRIP valve saves time and gas. There is no wheel to turn. No need to set the cylinder down to operate it. C-O-TWO gas can be discharged or stopped as quickly as you can close or open your hand. In fact, it's so easy to use that even a woman or a child can operate it and extinguish a fire in seconds.

SQUEEZ-GRIP, originated and developed by C-O-TWO, is now used by all the Armed Forces. C-O-TWO manufactures a complete line of Portables, Hose Units and Smoke Detecting Systems.

KILLS FIRE—SAVES LIVES—*It's Safer—It's Faster—It's Modern*

C-O-TWO FIRE EQUIPMENT COMPANY

"Automatic"
FIRE-FOG
★ IT BLANKETS ★ IT ISOLATES ★ IT QUENCHES ★

A War Time "Must"
-a Peace Time Need

DURING the past several months we've been telling you how "Automatic" FIRE-FOG licks really tough fires, particularly those originating in oils or other flammable liquids. Now, with censorship wraps off, here's the protection FIRE-FOG offers in the manufacture of munitions of war:

One of the largest powder plants in this country is at present producing tons of the new Rocket Powder under the protection of "Automatic" FIRE-FOG systems. One division of this factory alone averages 185 fires each day—over 5,000 fires every month! "Automatic" FIRE-FOG systems of protection put a torrent of water on these blazes within a half second of their inception, usually extinguishing them within five seconds. Most important, there are no injuries, no machinery damage, and often much of the powder remains unburned. Production at the powder rolling machines is restored within a matter of minutes.

All this has been made possible through the close cooperation of the powder manufacturer and "Automatic" engineers . . . *just the sort of cooperation between your staff and "Automatic" engineers that will result in licking your toughest fire problems in the peace time products of tomorrow . . . and TODAY.*

"Automatic" Sprinkler

"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA
YOUNGSTOWN, OHIO OFFICES IN 36 CITIES

"Automatic" manufactures and installs a complete line of fire protection devices and systems for all types of fire hazards. Listed by Underwriters' Laboratories, approved by Factory Mutual Laboratories.

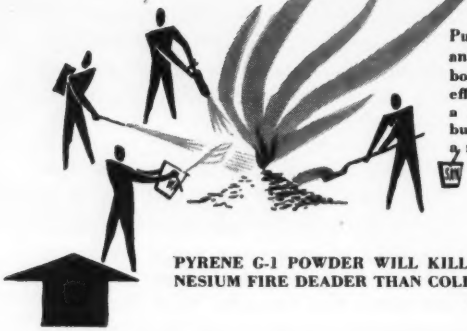
you get safer fire protection when you

standardize

your equipment

for example . . .

Here's a real terror of a fire . . . magnesium



Put water on a magnesium metal fire and the flames will flash up like a fire bomb. Other chemicals have no better effect. Even under a blanket of sand a magnesium fire will continue to burn so intensely that it may destroy a metal floor. It's highly dangerous!

PYRENE G-1 POWDER WILL KILL A MAGNESIUM FIRE DEADER THAN COLD ASHES.

Pyrene

HOW YOU GET MAXIMUM FIRE PROTECTION BY STANDARDIZING ON PYRENE

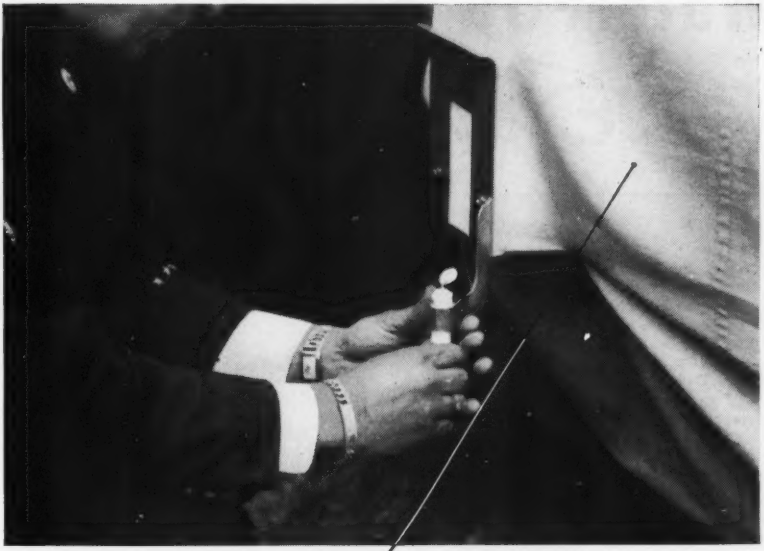
All Pyrene Fire Extinguishers are precision built of durable materials to give fast positive action on fires and long life for the equipment. The instructions for operation and care are simply stated and plainly stamped on the face of the extinguisher. 38 years of experience, creating, developing and testing new ideas for Fire Protection stand firmly behind the production of standardized Pyrene Equipment for every Fire Hazard. All Pyrene Fire Equipment has been tested, listed and labeled by the Underwriters' Laboratories, Inc., and approved by Factory Mutuals. Standardize, be safe with Pyrene.

By the way: When did you last test the fire extinguishers in your home?

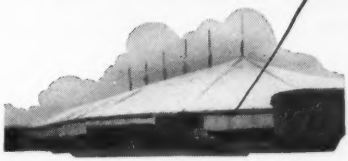
Pyrene Manufacturing Company

NEWARK 8, NEW JERSEY

AFFILIATED WITH THE C-O-TWO FIRE EQUIPMENT CO.



They had to be shown



The illustration above shows a close-up of the Pinkney flame test being conducted on a FIRE CHIEF Finished canvas sidewall of the Circus "Big Top" by officials of the District of Columbia Fire Department and the National Bureau of Standards.

The successful development of FIRE CHIEF Finish by Hooperwood "Canvas Engineers" has enabled manufacturers of tents, awnings, tarpaulins and canvas covers of all types to offer their customers a product that is positively fire resistant and proofed against the elements.

FIRE CHIEF Mill Finished Hooperwood Canvas will be available for civilian use as soon as canvas is released from government allocation.

FIRE CHIEF Compound, for applying to new or used untreated canvas, is now available in limited quantities to users who can certify to the need in the interest of public safety.

WM. E. HOOPER & SONS CO.

New York PHILADELPHIA Chicago

Mills: WOODBERRY, BALTIMORE, MD.

• Fire-Chief Finished •

HOOPERWOOD COTTON DUCK

WaterFOG AIDS FIREMEN IN *Spectacular "Rescue"*

There's an airplane inside that inferno — a dummy plane drenched in gasoline and then set on fire at the New Haven Fire Department's new training grounds.

Rockwood WaterFOG, delivered from two extension applicators, envelops a fireman who enters the roaring flames to save a dummy pilot, then rapidly cools and confines the blaze.

Speedier extinguishment of flammable liquid fires and an approximate 50% reduction in water damage are predicted by Chief Paul Heinz of the New Haven (Conn.) Fire Department, now that he has equipped his department with Rockwood WaterFOG nozzles and extension applicators.

WaterFOG nozzles make water effective against flammable liquid fires by transforming it into myriads of tiny particles—far smaller than spray — with tremendous heat-absorptive power. There's no splashing — a cloak of cooling, smothering fog falls gently over the combustion area, quickly controlling and confining the fire.

Industrial plants, too, protect lives and property with WaterFOG. Rockwood installations of fixed piping and WaterFOG heads are used by hundreds of refineries, chemical plants, utilities, etc. They are approved by Underwriters' Laboratories and Associated Factory Mutuals. Write for Bulletin 123. *Fire Officials and Executives!* Colored movie (16 mm.), showing tests of Rockwood WaterFOG, are available to city officials and business executives.

ROCKWOOD WaterFOG

WATER, ENGINEERED BY ROCKWOOD, COOLS, CONFINES, SMOTHERS OIL FIRES

ROCKWOOD SPRINKLER COMPANY

56 Harlow Street, Worcester 5, Mass.

Specialists in Fire Protection Engineering Equipment and Installation since 1907

Eliminate

Delayed Alarms

Reduce

Fire Losses

YOU CAN HELP

By urging the installation of a Box at Every Fire Hazard. This is essential protection.

Fire Alarm Boxes
Save Time and Protect Life, Property and Income

Write us for details

THE GAMEWELL COMPANY

Newton Upper Falls - - Massachusetts

EXTINGUISHING
Oil and Flammable Liquid Fires
WITH WATER

Mulsifyre, Mulsispray and FlameBuster are new weapons in the war on fire, exceptionally useful because they employ water, the cheapest and commonest ammunition. They cope successfully with liquid fire hazards where automatic sprinklers and hose streams, using the same ammunition, fail. Sometimes such hazards, usually small in extent but potentially dangerous, are found on premises best protected as a whole by sprinklers. In such instances one or another of the new weapons can easily be used to supplement the sprinklers, and thus insure a measure of safety from fire not otherwise possible.

MULSIFYRE SYSTEMS **are designed to extinguish flammable liquid fires such as in lubricating oil lines to generators, in transformer stations for circuit breakers, in bilges of oil-burning ships, etc. Mulsifyre Projectors are attached to a permanent piping system and spaced to command area beneath. In case of fire, Projectors discharge water with considerable force, converting burning liquid into an emulsion incapable of burning. Manual or automatic operation.**

MULSISPRAY SYSTEMS **are designed for the extinguishment of fires in volatile liquids and more particularly for the protection of tanks and equipment by cooling where the exact direction and application of water is a prime requisite. Mulsispray Systems are installed to meet the particular requirements of the hazards involved.**

FLAMEBUSTER **is designed for extinguishing fires in flammable liquids. It is a three-purpose portable hose nozzle for use with water, foam or chemicals, applied as a high or low velocity spray, or in a solid stream. Simple in design and technically sound, affording easy operation. Large orifices in spray heads practically eliminate clogging; straightway passages in nozzle body minimize friction loss. The FLAMEBUSTER has many applications.**

Surveys and estimates furnished without cost or obligation.

GRINNELL COMPANY, INC.
Executive Offices
PROVIDENCE 1, R. I.

Branches in Principal Cities